Peer tutoring for disadvantaged students in secondary school mathematics

Karen Lea

DEPOSIT AND CONSULTATION OF THESIS

One copy of your dissertation will be deposited in the Department of Education Library via the WebLearn site where it is intended to be available for consultation by all Library users. In order to facilitate this, the following form should be completed which will be inserted in the library copy your dissertation.

Note that some graphs/tables may be removed in order to comply with copyright restrictions.

Surname	Lea
First Name	Karen
Faculty Board	Education
Title of Dissertation	Peer tutoring for disadvantaged students in secondary school mathematics

Declaration by the candidate as author of the dissertation

1. I understand that I am the owner of this dissertation and that the copyright rests with me unless I specifically transfer it to another person.

2. I understand that the Department requires that I shall deposit a copy of my dissertation in the Department of Education Library via the WebLearn site where it shall be available for consultation, and that reproductions of it may be made for other Libraries so that it can be available to those who to consult it elsewhere. I understand that the Library, before allowing my dissertation to be consulted either in the original or in reproduced form, will require each person wishing to consult it to sign a declaration that he or she recognises that the copyright of this thesis belongs to me. I permit limited copying of my dissertation by individuals (no more than 5% or one chapter) for personal research use. No quotation from it and no information derived from it may be published without my prior written consent and I undertake to supply a current address to the Library so this consent can be sought.

3. I agree that my dissertation shall be available for consultation in accordance with paragraph 2 above.

Peer Tutoring for Disadvantaged Students in Secondary School Mathematics

Abstract

The aim of this action research project was to find an effective intervention programme that could be used in a secondary school to help close the achievement gap in mathematics between disadvantaged and non-disadvantaged students. The key feature of the intervention programme had to be that it would be low-cost and high-benefit. Peer tutoring was identified through the literature as a potential solution.

Peer tutoring has been written about extensively in the education research community since the 1970s, and as a result of the literature search two important themes emerged. Firstly, that a peer tutoring programme could have benefits beyond just academic attainment, so the project also looked at possible changes in mathematical self-concept. Secondly, that the way the peer tutoring was organised could have a significant effect on its success.

The organisational dimensions of the intervention programme were determined in some small part by constraints imposed by the setting, but mostly by evidence gathered from the literature. An 8 week peer tutoring intervention was put in place, with high ability Year 10 students tutoring Year 8 students twice a week for 20 minutes.

Academic attainment was measured using existing end of term tests so that the progress of the participants of the intervention could be compared against the whole cohort. Mathematical self concept was measured using an existing questionnaire that was adapted.

1

The results of the analysis of the test data showed that the Year 8 tutees had an accelerated rate of progress compared to students who did not participate in the intervention. The intervention did not seem to have any impact on the rate of progress of the Year 10 tutors. Similarly, an analysis of the questionnaire data showed that the Year 8 tutees experienced an increase in mathematical self-concept. The Year 10 tutors did not experience an increase, as their pre-test data showed they already had very high scores.

In conclusion, this research project showed that undertaking a peer tutoring programme in mathematics was a worthwhile endeavor; it met the initial aims of the project for having a good cost-benefit ratio. It is expected that this type of programme could be repeated in subsequent years with a similar group of students, and that it could possibly be extended to other subjects.

Contents

3

1 Introduction

1.1 Aim

This report details on an action research project that I carried out in the secondary school where I am Vice Principal, and also a mathematics teacher. The aim of this study is to find out if an effective intervention programme can be put in place for disadvantaged students in mathematics that has a high cost-benefit ratio. In summary this is for two reasons; firstly schools are under increasing pressure to "close the disadvantage gap", and secondly budgets for intervention strategies are being cut in the current funding context. This somewhat simplified assertion applies not just to my own school, but to many schools nationally. As such, the outcome of this research could have wide ranging benefits. If the intervention I undertake in this practitioner research is successful it can be rolled out to other subjects, other year groups, and indeed to other schools.

To expand on the first reason above: schools are measured on the performance of disadvantaged students at the end of Year 11 (aged 16 years). The various statistical measures for GCSE performance are given not only for the whole cohort, but also in terms of disadvantaged students (those who have been in receipt of free school meals in the last 6 years, or those in the care of the local authority). These measures are published for parents to compare schools, and are a critical measure in the national school inspection regime (conducted by the Office for Standards in Education, OFSTED). In the current climate of high stakes accountability if a school does not make significant efforts to ensure that disadvantaged students gain GCSEs that are at least as good as the rest of the cohort the school may be at risk of being perceived as failing. This could mean any or all of the

following: being placed into the "requires improvement" or "special measures" category by OFSTED; having increased inspections from the local authority; or in the worst case forced Academisation. In my professional opinion, based on my experience of being in school leadership for a decade in a number of different schools, school senior leadership teams feel it is extremely important to avoid all of these consequences. This is largely why I am motivated to undertake this study, why I have such an interest in it, and why I believe it will be of great interest to other school leaders.

Now regarding the second part of my claim; the need for schools to find high cost-benefit intervention strategies. Schools are under increasing financial pressure; funding has remained largely the same since 2010 but rising costs and a greater number of pupils mean that there is less available funding per pupil. Table 1.1 below shows the funding per pupil for my school over the last three academic years. Less money means there is little scope to employ additional subject specialists to work with underachieving students on a small group or one-to-one basis as may have happened in the past. Class sizes have had to increase, which also gives teachers less opportunity to work with underachieving students within lessons. Schools now have to look for creative solutions for helping underachieving students to catch up, and peer tutoring is a potential solution.

	2015 - 2016	2016 - 2017	2017 - 2018
Total spend per pupil	£5775	£5720	£5404

Table 1.1: Funding per pupil at my school over the past three years.

1.2 Types of maths intervention

Within the state secondary school setting in England, "intervention" usually refers to an activity undertaken with a group of students who have been targeted for a specific reason. Academic intervention usually has the goal of improving academic attainment. In my experience this has sometimes been as specific as moving a student or students from one grade or level, up to the next, due to the high stakes accountability of external exam results (referred to above). It can also be targeted at a specific group of pupils, for example girls or boys, or disadvantaged students.

1.2.1 Deployment of additional adults

Intervention generally takes one of two forms, although some schools may choose to use both simultaneously. Firstly there can be an in-class intervention, where an additional adult is deployed into the classroom to assist with a specific group of students. These students will receive more individual support than they otherwise would have. Alternatively the additional adult may withdraw a student or students to work with them in another room away from the main class. The second type of intervention is when students are required to attend extra maths lessons, in additional to their normal timetabled lessons. These might be within a student's own time ie. at break times or after school, or in some cases students may even be withdrawn from other lessons for maths tuition. In my professional experience, not only in the schools I have worked in, but in schools in the local area where I know colleagues, all of the above methods are regularly, almost routinely, employed. This is especially the case for English and maths.

The issue facing schools is that the tried and tested intervention methods outlined above all require additional teaching time from an adult. This may be a qualified teacher or otherwise, but either way they need to be paid for their time. With school budgets tightening there is often no longer any capacity to pay an additional adult. Even asking existing teachers to take on lunch time or after school tutoring becomes more difficult as budgets tighten, because teachers are already being asked to work right up to their capacity. Schools now need to look to other more creative ways of intervening with students. Peer tutoring could be one such example. One of its main appeals is the low adult "cost" with the potential high benefit of achieving a one to one ratio of tuition for a whole group of students.

In the following section I will examine some of the literature around peer tutoring to show that it can be beneficial to students, and is a viable option to use as a maths intervention. The main body of the literature review in chapter 2 will focus on the best way to organise the peer tutoring intervention, and possible ways to measure its effects.

1.2.2 Peer tutoring

A definition of peer learning is given by Topping (2005, p631) as "acquisition of knowledge and skills through active helping and supporting among status equal individuals or matched companions". For the purposes of the literature review I will define peer tutoring as one student teaching or instructing another or others, with minimal supervision from a teacher or other adult. Within the field of study of peer tutoring there is a huge range of research that analyses peer tutoring in many different forms. There is a plethora of literature around peer-tutoring, so to make coherent sense of it I have examined it in

9

chronological order. This is mainly because as a research community the authors usually referenced, and indeed built on, the major works that came before them.

From the 1970s several authors began to draw together individual studies that had been undertaken into peer tutoring, as the general consensus seemed to be that it could be beneficial to both tutors and tutees (Devin-Sheehan et al, 1976), but the evidence was sometimes weak. Anecdotally researchers and practitioners were reporting success with peer tutoring programmes, however studies often lacked reliability in their methodology, with experimental or quasi-experimental designs being often avoided due to ethical constraints. In particular, most of the research was practitioner research and lacked a control group. This meant that although the researchers could assert that some form of peer tutoring had helped students make progress, there was no comparable evidence to show that the students would not have made progress anyway. In addition, the variation in the nature of the studies meant it was difficult to make assertions regarding the types of conditions that would produce the maximum educational advancement in the tutees.

In one of the first publications of its type, in 1977 Hartley conducted a meta-analysis of 153 studies to show that peer tutoring was more effective than three other methods of intervention in accelerating students' progress in mathematics. Hartley found same age tutoring was as effective as tutoring from paid adult aides, with cross-age tutoring even slightly more effective than from adult aides. Interestingly, she also found that intensive supervision and instruction of the student tutors did not increase the effectiveness of the peer tutoring programme.

10

Topping (2005) published a review of developments in peer learning between 1982 and 2005. This built on his previous work in 2001. Rather than a meta-analysis this paper is a review of how peer tutoring has developed within the educational research community over time. This is helpful to me as it summarises an extended period when peer tutoring was being trialled and evaluated through practitioner research quite extensively, but usually on a small scale. Topping's work gives a historical perspective on peer learning, beginning with describing archaic perceptions of it as a linear model of transmission of knowledge, from teacher to the helper to the helped; the helper being a surrogate for the teacher. In this model the assumption was that the helper should be the best student, however it was being increasingly recognised that greater differentials between the levels of the helper and the helped produced an under-stimulating environment for the helper and made it less likely they would make cognitive gains. As such the trend moved towards helpers and the helped who were closer in capabilities. Topping claims that researchers and practitioners have started to accept that peer tutoring is different to teacher interaction, and involves different advantages and disadvantages.

Duran (2005) described the student in the peer tutor role as a mediator, and listed advantages of the mediator teaching another student, rather than an adult teacher. These include having a shared cultural and language background, and moreover, having recently studied the material themselves they may be able to be more sensitive about where potential difficulties and weak areas may lie.

Spörer and Brunstein (2009) found that peer tutoring was in some cases more effective than teacher instruction. They follow the tradition within the field of referencing the key

works on peer learning before setting out how their research will build on it, referring to many of the works also mentioned in this literature review, and seeking to add to the body of knowledge by comparing peer tutoring to traditional teacher instruction. In some ways this brings my literature review full circle as I began by looking at authors in the 1970s who were asserting the same point; that peer tutoring could be at least as effective as teacher instruction, if not more so. Many of the articles spanning the intervening decades focus on how to make peer tutoring the most successful, and do not return to the original question of whether peer tutoring in itself is a valuable activity. It is reassuring to know that such up to date research still promotes peer tutoring as an effective tool. There are limitations to using this study as it is about reading comprehension rather than maths, however the general principle still stands. Some interesting points to note are that students alternated between tutor and tutee, and that tasks are pre-structured. It is recognised however that if the peer tutoring is being used in a remedial way it is less likely that alternating roles will be beneficial.

1.2.2.1 Effect of peer tutoring on disadvantaged students

More recently, the Education Endowment Fund has foregrounded peer tutoring by recommending it as "moderate impact for very low cost, based on extensive evidence" ("Peer tutoring | Toolkit Strand", 2019). They claim it can have a positive impact with an average of 5 months additional progress. The evidence for this claim is founded in 17 educational research papers (9 of which are meta-analyses) from between 1982 and 2016. Some of these research papers also discuss specifically the positive effect peer tutoring can have on disadvantaged students, which makes this choice all the more appropriate for this research project.

1.2.2.2 Additional benefits of peer tutoring

Topping (2005) confirmed, as other authors have before him, that peer tutoring has the potential for cognitive gains for both the helper and the helped, however he also draws together evidence showing that peer tutoring can yield gains in transferable social and communication skills, and affective functioning such as self-esteem and feelings about the subject. This is the first paper I reviewed that gave definite insight into how and why the helper made gains, going beyond just the fairly obvious reasoning that "to teach is to learn twice". It is explained that for the helper to constantly monitor learner performance, pick up errors and misconceptions and adjust their teaching makes cognitive demands, therefore causing cognitive gains that extend beyond communication gains from having to crystallise a concept.

In their meta-analysis Ginsburg-Block, Rohrbeck and Fantuzzo (2006) found peer tutoring can be beneficial academically, but were equally focussed on the effect on behaviour, self-concept and attitudes as well as academic achievement. They found that not only could peer tutoring improve self-concept, but there was a correlation between the improvement of academic outcomes and behavioural outcomes. This will be a very interesting outcome to measure in my study; finding out if those that benefited academically also similarly benefited with social and self-concept gains.

Alegre Ansuategui and Moliner Miravet (2017) found similarly, that peer tutoring improves academic performance, self concept and solidarity. Although they did not attempt to make a correlation between the students who made these gains and the interplay between them,

13

the study is interesting as they quantified the self concept results rather than relying on qualitative data, so that statistical analysis could be carried out.

1.3 Research questions

The evidence from the literature on peer tutoring presented above has persuaded me that peer tutoring is a worthwhile avenue to explore in terms of planning an intervention programme for disadvantaged students. From my own professional standpoint it is also worthwhile as putting the intervention into place is relatively easy to organise and low cost, and could provide an innovative solution to an ongoing, and worsening, problem. There are very few, if any, other solutions on the horizon with similar characteristics. Peer tutoring could be put in place with minimal adult supervision, which is an important logistical consideration, yet there is the potential for a group of students to benefit.

1) Does a peer tutoring programme improve the academic performance of the tutees?
2) Does a peer tutoring programme improve the academic performance of the tutors?
3) Are there additional effects on the participants of peer tutoring, outside of academic gains?
4) Is there any correlation between students making academic progress and the additional effects?

The first research question is undoubtedly the most important, as the outcome of it will tell me if I have met the overall aim of this project, as outlined in section 1.1 above. If there is no evidence to suggest the academic performance of the tutees improves as a result of the peer tutoring intervention, it is unlikely that it would be seen as a worthwhile strategy to pursue, even if it produced positive academic effects for the tutors, or indeed non-academic gains for either group. I have included the other three research questions for

14

two reasons. Firstly, after reviewing the literature it is difficult to ignore non-academic

gains, or the effects on the tutors as these are such integral strands within the most recent

research. These outcomes will be very interesting to me both as a professional and as a

practitioner researcher. Secondly, the outcomes of the remaining research questions will

also serve as an important check. If there is evidence to suggest the peer tutoring

intervention programme has a negative effect, in either the academic or non-academic

realm then it could not be pursued without further adjustment to the programme.

2 Literature Review

The aim of the first part of the literature review is to inform the planning of the peer tutoring intervention. The research referenced in the introduction has already made a convincing argument that peer tutoring can be useful and students will benefit from it, however it has also made it clear that how it is organised can have a significant impact on the outcomes.

In the second part of the literature review, I will look into possible methods of measuring the potential non-academic gains from peer tutoring to answer my third research question. The literature has shown that it is possible students may make gains in social, emotional and behavioural areas due to peer tutoring, and so I need a reliable method of measuring student attitudes to mathematics and their self-concept so that I can answer my third research question.

2.1 Organisational dimensions to peer tutoring

Topping (2005) identified the most important change in the way the researchers were writing about peer tutoring between 1982 and 2005 was an increasing focus on the organisational variables of delivering it, and a recognition that the way the tutoring is organised will have a significant impact on the potential outcomes. He identified 13 organisational dimensions that peer tutoring can vary in, but does not give an indication on how these variables can be exploited for the best gains. I will use these organisational dimensions as a checklist when I am making decisions about how to best plan the intervention. For most of the organisational dimensions I will use the literature to inform the best choice, if there is one, however a small number of them will be pre-determined by organisational constraints.

I have mainly relied upon meta-analysis in this part of the literature review so that I can draw upon the largest body of evidence possible. It is also useful that in some of these meta-analyses the authors have attempted to attribute some effect size to the various different characteristics. This will be especially helpful to me when planning the intervention.

In 1982 Cohen at el built on Hartley's (1977) work on comparing and measuring the relative effectiveness of four different types of intervention by undertaking a meta-analysis of their own. They had identified several perceived limitations of Hartley's work and wanted to overcome these and focus on whether adjusting variables within the tutoring programme would make it more or less effective, and made an attempt to calculate the effect size of 15 different variables. These are different to Topping's 13 organisational variables, but there is some overlap. In the 65 studies they analysed they found little or no effect of a peer tutoring program on the self esteem of either tutors or tutees, but a positive effect on attitudes towards the subject being taught, and on and academic performance of both groups. Of the fifteen variables they originally defined five were found to have a significant effect size. The features that consistently produced strong effects were: structured programmes; tutor programmes of shorter duration (0 - 4 weeks); programmes where mathematics was taught; low-order skills being taught; and those when the effects were measured through an instructor developed test rather than a commercial standardized test. Hartley had only focussed on outcomes regarding academic achievement, rather than any effects on student attitudes (both tutors and tutees). Hartley was also conducting a

17

comparison between different types of tutoring on a broader level, rather than focussing only on peer-tutoring.

Ginsburg-Block, Rohrbeck and Fantuzzo (2006) looked at 36 studies in elementary schools and found effect sizes were too small to moderate, but peer tutoring was more effective when it involved student autonomy, individualised evaluation, structured student roles, interdependent group rewards and same gender grouping. In general, peer tutoring was more effective for low income urban students, students from a minority group, and younger students (grades 1 - 3 versus grades 4 - 6). The findings of this study seem to reinforce other literature I have previously referenced, and so I will use the information when designing my intervention even though it belongs to a different phase of education. There is no reason to believe that any findings here would be counter in older students, unless one of the other meta-analysis I look at provides evidence. I will transpose the idea of younger students being more malleable and so benefiting more from peer tutoring to the setting I am working in, and assume that this article recommends I carry out the intervention with key stage 3 rather than key stage 4 students.

Stenhoff and Lignugaris/Kraft (2007) examined 20 articles on peer tutoring, where each one had either a tutor or a tutee with a mild disability. This is relevant as some of the students who may be involved in the planned intervention for this study might be on the SEND register of the school. While I may not directly use their findings and make decisions about the organisation of my intervention based solely on this meta-analysis, it will be an additional useful source to consider along with the others, especially as Stenhoff et al were specifically looking at organisational dimensions of peer tutoring, and which has the

greatest positive effect on tutee outcomes. A drawback of their review is it only includes 20 articles, so for some variables it is difficult to come to a reliable conclusion, as the sample size for that particular type of setup is too small. This is indeed the case for the first variable looked at; the tutoring type. Four different types were identified (reverse-role, heterogenous, homogenous and cross-age), and although peer tutoring appeared to be beneficial in all cases there was not enough evidence to identify one particular type as better at increasing tutee outcomes. The second variable produced an outcome in contrast to a previous study I have looked at (Hartley, 1977), with Stenhoff et al finding that greater tutor training generally produced better tutee outcomes, as did ongoing monitoring of the tutors. Finally, the Stenhoff article does make reference to other benefits in addition to educational outcomes for the tutee, such as social and behavioural benefits for the tutors, however these are not analysed in enough depth for me to draw any useful conclusions from.

Topping, Miller, Murray, Henderson, Fortuna and Conlin (2011) found that the most effective peer tutoring interventions were when the participants were: girls; studying mathematics; in cross-age pairings; with the tutees being less able mathematicians. Although this is not a meta-analysis (that I have mainly relied upon thus far) it is particularly relevant in terms of the outcomes to my context, and is unusual in the peer tutoring literature as it involves a large scale randomised trial over two years. This is encouraging for the outcome of my intervention as although I can choose same-age or cross-age pairings the other variables mentioned are fixed by the organisational setting, so it is likely my intervention will mirror these conditions very closely.

19

Finally, a meta-analysis by Leung (2015) attempted to bring together 72 studies to determine best practice for practitioners setting up peer tutoring programmes. He built on the work of Cohen and Topping by including much more up to date research, limiting the studies used to those with reliable quantitative data, and only including studies specifically focussed on peer tutoring not other types of tutoring. In addition to the parameters considered that might moderate the effect of peer tutoring in previous meta-analyses Leung also considered new parameters. Leung synthesises the findings into four main recommendations for school practice, which is exactly what I need to design the most effective intervention. Some of these factors are useful as they reinforce that factors I have to fix because of the context, for example that same gender dyads are effective, and interventions in secondary schools have the highest effect size. Other factors are helpful to help me make decisions about the intervention: the sessions should be structured, and shorter duration is better. In mathematics the area students were able to make the most gains in were computational level practice.

Although the literature shows that there can be some benefit for both the tutor and tutee from peer tutoring, and that there are gains beyond just academic advancement, the primary aim of the intervention programme is to accelerate the academic gains of tutees, as such I will design the intervention with this in mind. There are three elements of the intervention programme that are already fixed: gender pairings, the SES status of the tutee and the subject being tutored. The first is because I am carrying out my research in a girls' school, so all of the peer tutoring pairs will be same sex. The second is that the tutees will be students who are classified as pupil premium. This is because the initial problem identified in my school was under-achievement of pupil premium students, and the lack of

any low or no cost interventions available to help close the achievement gap. The third is

that the peer tutoring will be only in mathematics. This is because although there is an

achievement gap for both English and mathematics it is greater in mathematics, so

mathematics has been chosen as the pilot intervention. My expertise is also in

mathematics.

Fixing the three variables above and choosing the others according to the findings of the

literature review will not hinder my research as the research papers analysed above show

that same sex pairings are advantageous and generally produce a greater effect size.

There is also some evidence that low SES students benefit more from peer tutoring, and

that peer tutoring in mathematics is at least as effective, if not more so, than in other

subjects.

In table 2.1 below I have outlined the remaining variables I must decide upon to plan the

intervention, and summarised any relevant findings from the literature review which will

help inform my decisions. They centre around who should be involved, what should be

taught and when. I have used the 13 organisational variables from Topping, in addition to

other variables that I think a decision needs to be made upon. Many of these were

suggested to me through the literature review.

Variable	Evidence from the literature and link to intervention design
Characteristics of the tutee*	More effective for minority, low-income, urban and younger students **Ginsburg-Block et al (2006).** 50% or fewer from minority groups **Topping (2011).**

	This is somewhat fixed from the outset, as the tutees will all be disadvantaged students. This is because the aim of the research project itself is to find an effective intervention for disadvantaged students who have fallen behind. I will not use ethnicity as a selection criterion. I am choosing to work with students from Year 8, as evidence points to younger students being more responsive, however I have avoided Year 7 for two reasons. Firstly, their data is not yet robust enough to determine who has fallen behind, as the baseline for secondary school is the end of Key Stage 2 data. In effect there will only have been one data drop in the Autumn term to be able to select the students from. Secondly, fairly intensive and widespread intervention in Year 7 is already in place for reading catch-up, and in my professional opinion putting some students in both reading and mathematics intervention would be counter-productive.
Cross-age or same-age tutoring*	Small effect size **Cohen et al (1982).** Cross-age **Topping (2011).** I will use cross-age tutoring, as my professional experience has shown me in the past that it can be more successful. Same age tutoring has the potential to make the tutees feel undermined.
Characteristics of the tutors*	Small effect size **Cohen et al (1982).** I am going to select students from Year 10 as this will enable cross-age tutoring. I am avoiding using Year 11 students as they are preparing for their GCSE exams.
Cross-ability or same ability*	I will use cross-ability, with the tutors coming from the top mathematics set. This should help to ensure that the tutors have enough of the relevant mathematical ability to assist the tutees. It will also mean they will feel confident in their teaching.
Contact constellation* e.g. one to one, or one tutor to two tutees etc	Dyads **Topping (2011).** I will set the peer tutoring up in pairs, with one tutor per tutee.
Role continuity*	Tutors and tutees should swap, unless the peer tutoring is being used in a remedial classroom **Spörer and Brunstein (2009).** I am going to keep roles the same throughout the intervention, with the older and more able student always being the tutor. This is because I am using this intervention to help students who have fallen behind to catch up, and as such they are weak mathematicians.

	I am also going to try to keep the pairings the same throughout the intervention, with the same tutor working with the same tutee every session. In the event of tutor absence there will be some reserve tutors.
Selecting the pairings	The data from the most recent mathematics test will be used to rank both the tutors and the tutees into ordered lists, and pair them accordingly to ensure the most proficient tutor is paired with the most proficient tutee and so on until the last pair is formed of the least proficient tutor with the least proficient tutee. This is an attempt to ensure that the difference in ability between tutor and tutee in each pairing in reasonably consistent.
Format of the tutoring	Should be structured **Cohen et al (1982), Ginsburg-Block et al (2006) and Topping (2011).** To try to ensure that all tutees receive the same type of instruction I am going to use mathematics catch-up workbooks. These workbooks have been used before in our mathematics department for low ability students and are from a reputable textbook publisher. The tutors will help the tutees work through the booklets. This should also help with keeping wasted time during the sessions to a minimum, as it means the pair can begin working independently of the adult. In my experience in the past making the structure too complicated means a lot of time is wasted. The use of computers also slows down the process of getting started in the sessions.
Curriculum content*	Lower level skills **Cohen et al (1982).** Student autonomy in goal setting is beneficial **Ginsburg-Block et al (2006).** Computational mathematics **Topping (2011).** The workbooks we will be using focus on basic mathematical skills, such as times tables, mental mathematics and using simple written methods for addition, subtraction, multiplication and division. The workbooks are all number skills, and do not contain any algebra, geometry or statistics.
Duration of the intervention	0-4 weeks **Cohen et al (1982).** Shorter duration **Topping (2011).** I will run the intervention for one school term, as I would like to keep the balance between a short enough intervention that it is still effective, and one long enough to have a measurable impact. It is also useful to run the intervention for one term as this will coincide

	with the testing schedule already in place for both the tutors and tutees. This will mean I do not have to put in place any additional tests, and can use data that is already being collected for the whole year group. The Spring term that I will use is 11 weeks long, however the intervention will only run for 8 weeks. This is because the first two weeks will be used for tutor selection and training, and the end of term test actually takes place in the penultimate week so there will be no peer tutoring in the last week once the test has taken place.
Timing of the intervention session* e.g. in class or out of class	Practical considerations take precedence here, as it is difficult to find an appropriate time in the school day to implement an intervention. From an ethical perspective I do not want to withdraw students from their break or lunch time, and in addition I think it would make the intervention less effective anyway as it may be perceived as a punishment. This would be the same for an after school intervention which could be seen as a detention. I would not want to withdraw students from their regular mathematics classes, as this would change the nature of the study, as it would then become more of a comparison between teacher led and peer led teaching. It would also be unfair to the students being used as tutees as they would be missing vital instruction. As such the only time left in the school day to use is tutor time.
Length of the intervention sessions	The tutor time slot is 20 minutes long.
Tutor training	Intensive instruction and supervision does not increase effectiveness **Hartley (1977).** Small effect size **Cohen et al (1982).** Greater tutor training and monitoring produced better outcomes for the tutees **Stenhoff and Lignugaris/Kraft (2007).** I will provide some training for the tutors, but it may be limited by practical considerations. The tutors will be trained in the two 20 minute sessions in the week preceding the intervention starting. Tutors will be given the workbooks, and will practice on each other. They will be given some advice about how best to help a tutee without actually giving the answer by the adult that will be supervising the intervention sessions. This will be carried out by the adult who will be supervising the intervention; the maths academic assistant for the department.
Frequency of the intervention sessions	Again, some practical considerations come into play here, as the maths academic assistant supervising the sessions can only be available two days per week. I am choosing two sessions per week rather than one however, as I think this will increase the potential

	for academic gains.
Location of the intervention sessions*	The intervention will run in a mathematics classroom. This is practical in the sense that the materials are stored here, and that the maths academic assistant supervising is based in this room. There are also not a great deal of alternatives, except for classrooms of other subjects.
Voluntary or compulsory*	The tutees will be selected according to the test data, however they will be given the opportunity to opt out if they do not want to participate. In my experience forcing students to do extra mathematics is not constructive. The tutors will be asked to volunteer, as I think this will produce better results, as they will be more enthusiastic, and more likely to attend every session which is important for continuity.
Reward*	Interdependent group rewards **Ginsburg-Block et al (2006).** I will offer both tutees and tutors a reward at the end of the intervention based on attendance at the sessions. My school uses a system of reward points, which the students are very motivated by, so I will offer students points for every session they attend.

*Organisational variables identified by Topping (2005)

Table 2.1 Decisions on the organisational dimensions of the planned intervention

programme.

The last way Topping (2005) will help inform my intervention design will be that he gives

two examples of cautionary tales where peer tutoring can be detrimental. The first is when

an older and therefore more credible helper does not actually have better knowledge and

so teaches incorrectly, leading to "faulty learning". The second related concept is

"meta-ignorance"; where the helper does not realise that they do not have the correct facts.

I will attempt to mitigate the chances of this happening by having a trained adult supervise

the peer tutoring sessions at all times, who should be able to pick up on any potential faulty

teaching, and if necessary correct it.

2.2 Measuring possible outcomes

2.2.1 Mathematics self concept

Among the many benefits of peer tutoring that go beyond only the academic, the one that seems to recur the most in the literature I reviewed in the introduction is self concept. The difficulty is what the definition of this is. Authors do not seem to agree on a general definition, however by bringing together multiple definitions one can begin to understand what is meant by self concept. Alegre Ansuategui & Moliner Miravet (2017) identified the key elements of mathematics self concept as: interest in mathematics; efficiency in mathematics; motivation in mathematics; taking pleasure in mathematics; attributing mathematics success or failure to chance. The OECD (2013) in their PISA tests looking at student engagement and drive and self belief used the following questions to measure self belief: I am just not good at mathematics; I get good grades in mathematics; I learn mathematics quickly; I have always believed that mathematics is one of my best subjects; In my mathematics class I understand even the most difficult work. In the methodology chapter that follows I will explore how I can measure self concept in the participants of the intervention programme, using some of the definitions given here.

3.0 Methodology

3.1 Contextual information about the school

The school is small (720 students), with only girls in Year 7 - 11 (aged 11 to 16 years), set in a town centre just outside of London. There is a very small mixed sixth form (55 students aged 16 to 19 years). The school is not currently full, with spaces in Years 9, 10 and 11. The school was previously in special measures (2012) but has since received two "Good" grades from OFSTED. This accounts for the difference in student numbers in the lower and upper school. Since 2016 the school has been oversubscribed for Year 7, however it is still struggling to recruit into the sixth form.

The school is non-selective in a local authority that has a selective system, with students opting to take the 11+ exam if they wish to attend a Grammar school. Around 25% of the highest ability students in the county attend local Grammar schools. As such the school has a slightly lower than average ability profile on entry.

Table 3.1 below shows that in my school disadvantaged students as a group perform worse on average than the whole cohort across a range of measures. The four measures I have included in the table are generally accepted as the Government's "headline figures".

	England state-funded schools	School (Whole cohort)	School (Disadvantaged students only)
Progress 8 score	-0.02	-0.02	-0.73
Attainment 8 score	46.5	41.1	34
Grade 5 or above in English and maths GCSEs	43.3%	31%	16%
Grade 4 or above in English and maths GCSEs	64.2%	57%	39%

Table 3.1 Progress and attainment data for my school, including disadvantaged students compared to national data for GCSE results in 2018.

Table 3.2 below shows that this situation is actually getting worse over time, as the Progress 8 figure for disadvantaged students is falling, and crucially, the school is not closing the gap. This data cements the argument for the need to put interventions in place to support disadvantaged students, and preferably in English and/or maths as these account for four tenths of the total Progress 8 figure, both being double weighted.

	2016	2017	2018
School (Whole cohort)	0.06	-0.22	-0.02
School (Disadvantaged students only)	-0.51	-0.7	-0.73
Difference	0.57	0.48	0.71

Table 3.2 Historical Progress 8 scores for my school, including disadvantaged students.

3.2 Organising the intervention

Before the intervention began a meeting was held with the following people to discuss the aim of the intervention, and the logistics of how it would run. Although this intervention is

the basis of this academic study, it also fits into a wider picture of the schools'

Improvement Plan. Present were: myself, Vice Principal, and leader of the project; the

Associate Vice Principal who has responsibility for Pupil Premium and data and

assessment; the Director of Learning for maths; the Key Stage 3 leader for maths; the

maths teacher who has a whole school responsibility for Pupil Premium and the maths

academic assistant. Roles were allocated as follows:

Person	Task allocated
Associate Vice Principal	Providing up to date assessment data for Year 8 to enable selection of tutees.
Director of Learning for maths	Recruitment and selection of tutors from her Year 10 top set maths class.
Key Stage 3 leader for maths	Ensure adequate workbooks were available for the intervention.
Teacher responsible for Pupil Premium	Meet individually with the tutees once they have been selected and explain the intervention.
Maths academic assistant	Provide the training sessions for the tutors and supervise all the intervention sessions.

3.2.1 Selection of students as tutees

The first criteria for the selection of tutees was that the students must be classified as Pupil

Premium (The students at my school who are Pupil Premium fall into that category

because they have been in receipt of Free School Meals at some time within the last 6

years. There are some other criteria for which students can qualify for Pupil premium but it

does not apply to any students in my school). This is because the aim of the research

project was to find out if an effective intervention programme could be put in place for

disadvantaged students. The second selection criteria was that the students have already

fallen behind, and not made as much progress as they should have at secondary school so far. The school employs a rigorous data collection and analysis system, with students expected to make one sub-level of progress every 2 terms. The baseline for the students is their end of Key Stage 2 SATs score, which is converted into a GCSE style grade (1 - 9) and given a sub-level (developing, secure, mastered). By the end of the first term in Year 8 (Christmas) students should have made 2 sub-levels of progress.

16 students were identified who met the above criteria, and a meeting took place with the teacher in charge of Key Stage 3 maths, and the teacher in charge of Pupil Premium students to decide which students would be appropriate for the intervention. Two were ruled out from taking part in the intervention programme as their attendance at school was too low (less than 75%). A further two were ruled out as it was felt by the teachers who knew them that they would not engage in the intervention, and would be unlikely to attend the sessions. The remaining 12 students were selected as the tutees for the intervention.

3.2.2 Selection of students as tutors

From the literature review I had already identified that the tutors should be older than the tutees, however I had already decided that I would not involve Year 11 students as they are preparing for GCSE examinations, so Year 10 students were chosen, who were able mathematicians. As such the class teacher asked the class of top set Year 10 students who would like to volunteer to be a tutor. The students were briefed about the details of the intervention programme so that they could decide whether they would be able to commit to it or not. 19 students volunteered, and their class teacher who is also the Director of Learning for maths cut the list down to 14 students, based on her professional opinion of

the students. She chose the students who she felt were the most confident, and also those who would be most likely to attend every week. It was intended that 12 students would be paired up with tutees, and 2 students would be reserves, to fill in if another tutor was absent.

3.2.3 Tutor training

In the first two sessions the maths academic assistant worked with the tutors without the tutees to prepare for the intervention. In the first 20 minute session they discussed what qualities were needed to be an effective tutor, and the difference between helping and telling someone else the answer. In the second session the workbooks were handed out and the tutors paired up to take it in turns to practice tutoring the other. The maths academic assistant reported back that the training sessions went very well, and the year 10 tutors were all very enthusiastic to begin the intervention programme.

3.2.4 Peer tutoring subject content

From the literature review it was evident that the most effective form of tutoring was basic computational mathematics. Therefore a catch-up workbook was selected that contained basic practice on four operations with number. These workbooks had been used before in one to one intervention by the maths academic assistant, and were found to be useful. They were also from a reputable publisher that the school had purchased many different revision guides and textbooks from before.

I also discussed the content of the intervention with the other teachers in the department, all of whom agreed that lack of basic computational skills is often what is holding a student

back. The Key Stage 3 scheme of work is designed to follow on from the Key Stage 2 scheme of work, so although it does cover the basic operations it does not do so in any great detail as this is assumed knowledge by the time students start secondary school in Year 7. An example that was cited by the department was that when teaching sharing an amount into a given ratio, students can conceptually understand the steps needed to complete the task, but struggle with the basic arithmetic needed (addition, division and multiplication).

3.3 Measurement of outcomes of the intervention

The primary goal of the intervention is firmly the academic achievement of the tutees, however, as part of my research I am also measuring self-concept, and investigating if there is a link between the improvement in both of these areas. To test if there is a statistically significant difference in both academic achievement and mathematical self concept before and after the peer tutoring intervention programme I will use a T-test for dependent means. To measure correlation I will produce a scatter graph and calculate the Pearson's Product Moment Correlation Coefficient.

3.3.1 Academic attainment

Students in the school are already routinely given mathematics tests every term, so this data would form the basis of measuring any advances in academic attainment, without the need for any further testing. The tests used are from the Exam Board that the school uses for GCSE, and are intended for use at Key Stage 3. This means that the tests have been externally validated and written by professionals. Using pre-existing external tests also helps eliminate any researcher bias.

The disadvantage of using the school test data is that the results are given in sub-levels, which are still quite large increments to advance. Students are only expected to make one sub-level of progress in two school terms, so even if a student does benefit from the intervention it may not necessarily show up immediately in the end of term test. A lot of progress can be made within a sub-level, which the test will not show.

3.3.2 Changes in self concept

To measure the potential changes in mathematics self concept from before and after the peer tutoring intervention I decided to use a questionnaire. The main aim of the questionnaire was to find out if students enjoyed maths and felt they were good at it. I wanted to use a questionnaire so that I could quickly and easily get responses from the students, and then most importantly use the same questionnaire again to compare the participants answers after they had taken part in the intervention.

I ruled out interviews as a data collection method as I felt the students might be unduly influenced by me as the interviewer as I teach some of the students. This would undermine the validity of the data collected. It would also be more difficult to undertake statistical analysis with the data and try to find out if there were any significant differences in attitudes before and after the intervention.

Another reason for ruling out a method that would provide me with more qualitative data such as an interview or a focus group was that for the purpose of this study I am less interested in why students feel the way they do regarding mathematics self concept, and

more interested in if it changes over time, and if this change can be either attributed to the peer tutoring intervention, and potentially correlated with academic gains.

3.3.2.1 Writing the questionnaire

Mathematics self concept is a difficult idea to define, indeed in the literature around self concept there are varying ideas. This meant that without a solid basis for what I was looking for it would be even more difficult to formulate from scratch questionnaire questions that tested for self concept. Instead of trying to write my own questionnaire I decided to try to locate and use one of the questionnaires used in the literature I reviewed where peer tutoring had a positive effect on mathematical self concept.

Many of the research papers that reference gains in self concept through peer tutoring do not include the technical appendix to show how it was measured, however in the Alegre Ansuategui and Moliner Miravet (2017) paper they stated that they used a previous questionnaire that was designed specifically to test self concept in maths by Gil Ignacio, Guerrero Barona and Blanco Nieto (2006). This questionnaire contained 52 questions and was originally written in Spanish, as it was used for a study conducted in Spanish schools (see appendix 1).

3.3.2.2 Refinement of the questionnaire

I used translation software to convert the questionnaire into English (see appendix 2) and edited it for my own purposes (see appendix 3). Most of the edits were grammar corrections, or substituting words into a more recognisable venacular for English speaking students, also taking into account that the students it would be used on would be around

12 years old and some may have a limited vocabulary. For example, I changed all instances of "math" to "maths", and "economically remunerated professions" to "well paid jobs". I tried in all cases to preserve the intent of the question.

The answer scale in the original questionnaire was 4 tick boxes: strongly agree, agree, disagree and strongly disagree. In most of the questions it is clear which end of the scale would show that a student has a strong mathematical self concept, however in some it was not clear to me so I deleted those questions. I also deleted questions where I felt there was repetition. This was partly to achieve a shortened overall questionnaire, as I know from my professional experience that asking younger students to complete a questionnaire can be a difficult task and they would be unlikely to be able to complete all 52 questions.

I also edited the questionnaire with my results analysis in mind. Data analysis on 20 or more individual questions would be arduous, and the overall picture may be lost in the detail. This would especially be true as I would actually be comparing 4 questionnaires, not analysing one. I intended to give the questionnaire to both the tutees and tutors, before and after the intervention. In this way I would not only measure the change of an individual group, but also compare the results between the groups. The completed edited questionnaire was 25 questions, with 5 questions for each category to demonstrate the key aspects of maths self concept that Alegre Ansuategui and Moliner Miravet identified.

Finally, I decided that in the answer scale I would include "neither" to separate agree or disagree. In my data analysis I would give each question a score of 1 to 5, according to whether the answer showed strong mathematics self concept or not, and then a total could

be found for each group of questions. I would be able to calculate descriptive statistics such as mean, median, mode and range, as well as look for statistical significance in any changes in scores between the pre and post intervention questionnaires.

3.3.2.3 Pilot study

The pilot study questionnaire was given to a group of Year 7 students in my school. I chose this group of students as they would be similar, if a little younger in age to the intended participants, and of a similar ability level. If the Year 7 students could understand the questionnaire and the instructions on how to complete it then it would be very likely the Year 8 and Year 10 students it was intended for would be able to also. The Year 7 students were given an unlimited amount of time within a normal maths lesson, and were given the opportunity to opt out if they wished. I explained the purpose of the overall research, and of the pilot questionnaire, before giving it out (see appendix 4).

23 students completed the pilot questionnaire and provided feedback (see appendices 5 and 6). Their feedback is summarised as follows:

- Students did not know whether to tick or cross or circle the boxes. As a result an additional instruction will be placed at the top of the first page asking students to tick a box.
- One student ticked multiple boxes on the same question, so I will include in the instruction that only one box should be ticked for each question.
- 5 students said they found question 13 confusing. As a result I edited it to say "When I solve a maths problem successfully it is more down to luck than my own skill", so that it was clearer to the students what I was trying to find out.

- 4 students said they found question 8 confusing. As a result I edited it to say "If I do well in maths it is because the teacher likes me".

Other questions were mentioned by students as confusing, or they did not want to answer them, however as each other question mentioned was only by one student each out of the 23 asked I have not made any further amendments to the questionnaire (see appendices 7 and 8) . Although I want to make the questionnaire accessible to the study participants I also want to preserve most of the original intent by the authors so that it remains as valid as possible as a way of measuring mathematical self concept. The maximum time any student took to complete the questionnaire was 17 minutes, so I will allow 20 minutes when I administer the questionnaire to the participants of the research project.

3.4 Validity and reliability

The main concerns for reliability in the outcome of this research are the data collection methods. I am satisfied as a researcher that using the internal test data from the school instead of giving the participants of the intervention additional tests will yield reliable results. This is because the tests are sourced from an exam board, and have already been checked and tested. The tests are marked with a supplied mark scheme, and the mathematics department undertake moderation to check for consistency across teachers.

The questionnaire testing mathematical self concept is much more difficult to justify as wholly reliable, as self concept is such a difficult concept to define in itself. It has been used in previous peer reviewed published research, although for my purposes I edited the length of the questionnaire so it was shorter. The use of the questionnaire not to make an

37

absolute judgement on mathematical self concept, but to measure the relative change before and after the intervention lends a dimension of reliability, as I am not scoring the questionnaire itself. There may be questions left out which would point to an important facet of mathematical self concept, however for the purposes of this research the questionnaire will be adequate. The primary aim of the research is to find an intervention which advances academic attainment, with the potential increase in mathematical self concept being somewhat of a secondary benefit, if found.

3.5 Representativeness

The sample size I am taking (12 of each tutors and tutees) is necessarily small for logistical purposes in running the intervention. It is not intended to be representative of the population, as the tutees have been chosen with specific characteristics, i.e. Pupil Premium and low attaining. However these students are probably representative of other students with similar characteristics. As such, if the peer tutoring intervention programme is successful then it is likely it will be successful again if we run it in subsequent years.

The school is a fairly typical non-selective school in Kent, so the students can be seen to represent a wider population of students who share the same characteristics. The drawback of my research in terms of applying it to other schools is that it will be carried out in a single sex setting, so it may not be sensible to assume that the same result would be achieved in either an all boys school, or a mixed school.

3.6 Ethical considerations

Permission was sought and granted from the headteacher (see appendix 9), and CUREC approval was given by the University (see appendix 10).

3.6.1 The intervention

The intervention undertaken in this research was not dissimilar to other interventions we might run as a matter of course within school, in that the mathematics department academic assistant oversaw it, and students came out of tutor time to do it. The significant difference was that students were being taught by other students, not by a qualified adult. I was sufficiently reassured by the literature review that peer tutoring could only have either no impact on academic attainment, or a positive effect. The intervention was in addition to the normal mathematics teaching the students would usually receive, not instead of, so I did not feel the students taking part would be disadvantaged in any way. I also organised the intervention with students of a sufficiently higher capability in mathematics so that it would be unlikely they would teach the subject content incorrectly. The intervention was staffed at all times by the mathematics department academic assistant, who could easily get around all 12 pairs. This was the main reason for restricting the number of pairs involved in the intervention.

3.6.2 Measuring outcomes

Measuring the academic attainment gains did not involve giving the students any additional tests. The test data was kept anonymous by assigning each student a number identifier. The data was also kept confidential and secure.

The questionnaire given to the students to measure mathematics self concept were similar to questions sometimes given to students as part of a student voice activity. It was explained to the students that they did not have to answer the questionnaire, and that the answers they gave would be anonymous and confidential.

4 Presentation and analysis of findings

In this section I will analyse the data collected about both academic attainment and mathematics self concept before and after the peer tutoring intervention programme for both the tutors and tutees. I will also attempt to find out if there is a correlation between each variable for both tutors and tutees.

4.1 Attendance at the intervention sessions

One of the factors that could have hindered the success of the peer tutoring intervention programme would have been non-attendance. Before attempting to analyse if the intervention had any effect on the participants I will look at their attendance. If any student missed sessions it might have a bearing on how much progress they could have potentially made.

Table 4.1 below shows that each tutee only missed a maximum of one session when they were present in school on that day but chose not to go to the intervention. If a student did not attend the intervention then a member of staff spoke to them the following day and stressed the importance of attendance.

There does not seem to be any correlation between attendance at the intervention sessions by the tutees and how much their self concept scores changed by. The Pearson's Product Moment Correlation Coefficient is 0.029, which indicates no correlation.

Tutee number	Attendance %	Reason for absence %		Overall change in scores for each self concept area (maximum score =25 in each area)					
		Absent from school	Did not attend sessions	Interest in maths	Perceived Efficiency in maths	Motivation in maths	Attributing maths success or failure to chance	Taking pleasure in maths	Total
1	100			1	2	0	1	2	6
2	75	25		3	5	2	0	0	10
3	62.5	37.5		0	1	0	0	0	1
4	62.5	25	12.5	4	3	0	0	0	7
5	87.5		12.5	0	0	0	0	0	0
6	100			0	0	2	0	0	2
7	87.5		12.5	0	0	0	1	0	1
8	75	12.5	12.5	0	4	0	0	1	5
9	87.5	12.5		3	3	2	0	0	8
10	100			8	5	0	2	0	15
11	87.5		12.5	1	0	2	0	0	3
12	100			0	0	0	0	0	0
Mean	85								

Table 4.1 Attendance at the intervention sessions with changes in scores for self concept.

4.2 Changes in academic attainment

To analyse the changes in academic attainment I have only used the internal test data already generated within the school (see appendices 11 and 12). I have compared the groups participating in the intervention with the rest of the cohort; the rest of the cohort being divided into pupil premium and non-pupil premium students to try to control for that effect. If there were any students with missing pieces of data I discounted that student from the statistical analysis.

4.2.1 Changes in academic attainment for the tutees

Table 4.2 below shows that the students that were selected for the intervention had only made 0.75 sub-levels of progress from the end of key stage 2, until the end of the autumn term in Year 8 (4 whole terms). In this time the students should have made 2 sub-levels of progress. The other pupil premium students who were not included in the intervention had made 1.58 sub-levels of progress. Although this is twice as much, it is still not as much as the average for the non-pupil premium students who had on average exceeded the target with 2.10 sub-levels of progress. This is clear evidence showing that pupil premium students do, on average, underachieve right from the start of their secondary education in my school, while non-pupil premium students overachieve.

Between the start and the end of the intervention, which lasted one term, the pattern is repeated, with the pupil premium students making less progress than the non-pupil premium students. However, the pupil premium students participating in the intervention have accelerated their rate of progress. They have, on average, made as much progress in the one term they were involved in the intervention as they had in the four terms they had been in the school so far. Diagram 4.1 below shows that the rate of progress for the intervention group has changed the most of all the three groups of students.

Interestingly, all students seem to have made more progress than in the previous time period whether they were in the intervention programme or not. There may be many external factors this could be attributed to, and there is not enough evidence to say this was anything to do with the peer tutoring intervention running. It does add weight, however, to the argument that a peer tutoring intervention programme is beneficial.

43

	Mean sub-levels progress from KS2 to the start of the intervention	Mean progress between the start and end of the intervention
PP & in intervention	0.75	0.75
PP & NOT in intervention	1.58	0.79
Non PP	2.10	0.89

Table 4.2 Average (mean) sub-levels of progress made by groups of students between KS2 and the start of the intervention, and over the course of the intervention.
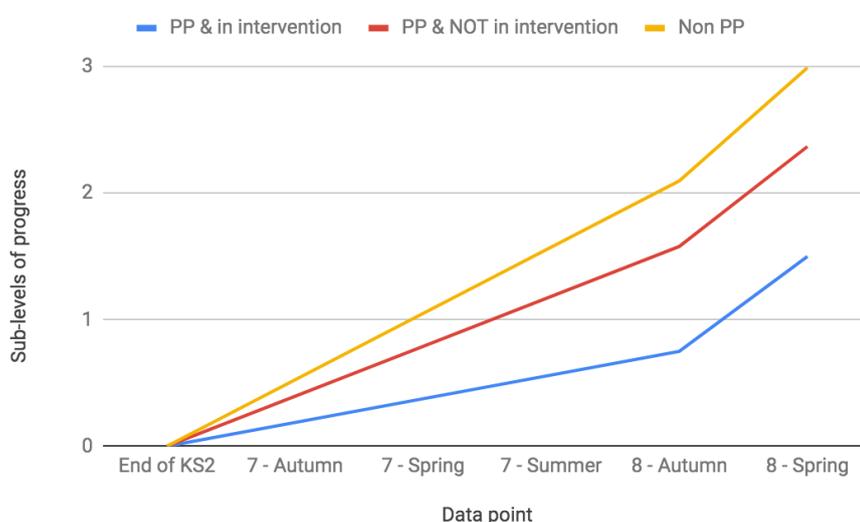
Diagram 4.1 Sub-levels of progress made by three different groups of students between the end of Key Stage 2, the start of the intervention, and the end of the intervention.

4.2.2 Changes in academic attainment for the tutors

Table 4.3 below shows that the students who volunteered to be tutors in the intervention were those who had already made the most progress compared to the rest of the cohort over the course of Key Stage 3, and the first term of Year 10. This may be expected, as the tutors were exclusively chosen from the top mathematics set, and it would be reasonable to say that a student who wanted to volunteer for maths intervention and help younger students would have enjoyed some success in maths already themself.

As in the Year 8 data for the tutees, the data for the Year 10 tutors shows that there is a difference between pupil premium and non-pupil premium students for the rest of the cohort that were not involved in the intervention. I have broken down the rest of the cohort in this way as all of the Year 10 tutors were non-pupil premium, so comparing them to the other non-pupil premium students gives a fairer picture.

	Mean progress over KS3	Mean progress in 1st term of Year 10	Average progress in 2nd term of Year 10
In intervention	5.00	1.42	1.67
Not in intervention and non PP	4.00	0.35	0.78
Not in intervention and PP	3.62	0.28	0.72

Table 4.3 Average (mean) sub-levels of progress made by groups of students over Key Stage 3, in the first term of Year 10 and in the second term of Year 10.

Diagram 4.1 below shows that although the students who participated in the intervention as tutors made the most progress over the course of the intervention, they were already doing so since the start of Year 10. It does not appear that participating in the intervention had an impact on accelerating their academic attainment.
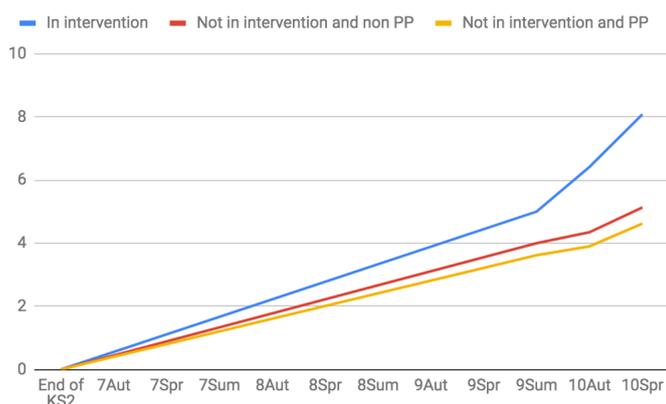
Diagram 4.2 Sub-levels of progress made by three different groups of students between the end of Key Stage 3, the start of the intervention, and the end of the intervention.

45

4.3 Mathematics self concept changes

I gave the self concept questionnaire to both the tutors and tutees, as I was interested to find out how their self concept might have similarities or differences in the pre-test, given that the tutee group was by definition a group of students who were weak mathematicians and have fallen behind, and the tutors were a group of students who have excelled in maths and have volunteered to take part in the peer tutoring programme, so one could assume that on some level they enjoy maths and feel they are good at it (see appendix 13).

4.3.1 Mathematics self concept changes for the tutees

<u>Interest in maths</u>

Interest in maths summary			
	Tutees before	Tutees after	Tutees change
Mean	3.25	3.58	0.33
Median	3.5	4	0.5
Mode	4	4	0
Range	4	4	0

Table 4.4 Summary statistics for the self-concept questionnaire answers for "Interest in maths" for the tutees before and after the peer tutoring intervention.
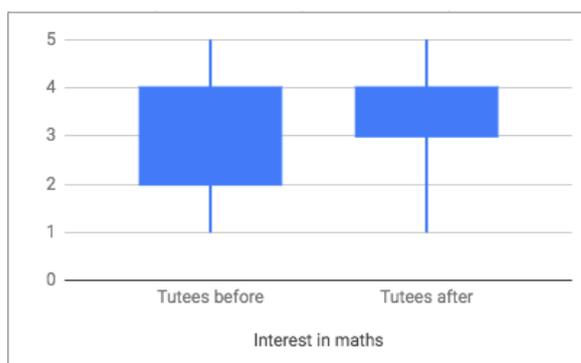
Diagram 4.3 Distribution of answers for the questions about "Interest in Maths" before and after the peer tutoring intervention programme.

There was a change in the mean scores for interest in maths of 0.33 for the 12 tutees. Using a T-test for dependent means this change is statistically significant ($t = 2.35, p < 0.05$). The box and whisker plot shows that although some students improved their score, it was not effective for all students as the minimum remained at 1. Out of the 12 participants, 6 did not change their overall score for interest in maths at all. Of the 6 participants that did have a different score after the intervention, all of them moved in the positive direction.

Perceived Efficiency in maths

Perceived Efficiency in maths summary			
	Tutees before	Tutees after	Tutees change
Mean	3.87	4.25	0.38
Median	4	4	0
Mode	4	4	0
Range	3	3	0

Table 4.5 Summary statistics for the self-concept questionnaire answers for "Perceived efficiency in maths" for the tutees before and after the peer tutoring intervention.
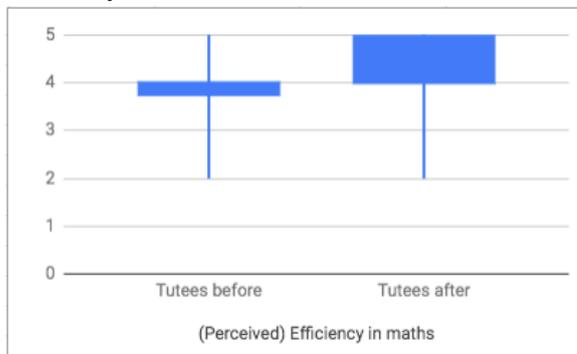
Diagram 4.4 Distribution of answers for the questions about "Perceived Efficiency in Maths" before and after the peer tutoring intervention programme.

There was a change in the mean scores for perceived efficiency in maths of 0.38 for the 12 tutees. Using a T-test for dependent means this change is statistically significant ($t = 3.29, p < 0.001$). The box and whisker plot shows that as with the results above for interest in

maths, the intervention did not have the same effect on all students. 5 of the participants

did not change their score at all. The 7 participants who did change their score all did so in

the positive direction.

Motivation in maths

Motivation in maths summary			
	Tutees before	Tutees after	Tutees change
Mean	3.90	4.03	0.13
Median	4	4	0
Mode	4	4	0
Range	3	3	0

Table 4.6 Summary statistics for the self-concept questionnaire answers for "Motivation in maths" for the tutees before and after the peer tutoring intervention.
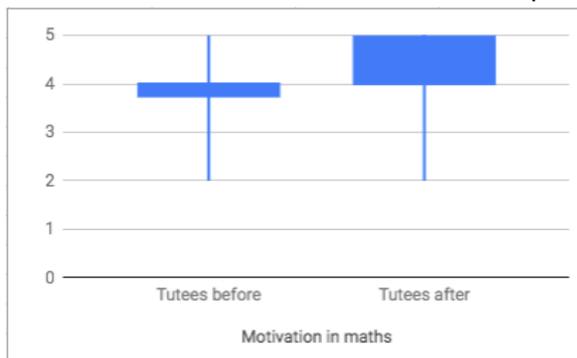
Diagram 4.5 Distribution of answers for the questions about "Motivation in Maths" before and after the peer tutoring intervention programme.

There was a change in the mean scores for motivation in maths of 0.13 for the 12 tutees.

Using a T-test for dependent means this change is statistically significant ($t = 2.35, p <$

0.05). Of the 12 participants, 8 of them returned the same overall score for motivation in

maths after the intervention. The 4 participants who's score did change, all increased by 2

overall each. This is the smallest amount of change so far of the five self concept areas.

48

Attributing maths success or failure to chance			
	Tutees before	Tutees after	Tutees change
Mean	3.83	3.90	0.07
Median	4	4	0
Mode	4	4	0
Range	3	3	0

Table 4.7 Summary statistics for the self-concept questionnaire answers for "Attributing maths success or failure to chance" for the tutees before and after the peer tutoring intervention.
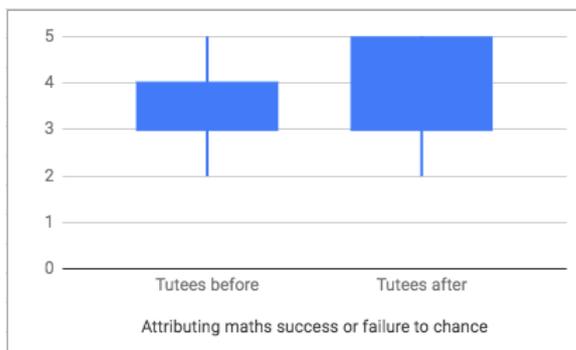
Diagram 4.6 Distribution of answers for the questions about "Attributing Maths Success or Failure to Chance" before and after the peer tutoring intervention programme.

There was a change in the mean scores for attributing maths success or failure to chance of 0.07 for the 12 tutees. Using a T-test for dependent means this change is not statistically significant. Of the 12 participants, only 3 changed their overall score at all for attributing maths success or failure to chance; each only by one or two points.

Taking pleasure in maths

Taking pleasure in maths			
	Tutees before	Tutees after	Tutees change
Mean	3.63	3.68	0.05
Median	4	4	0
Mode	4	4	0
Range	4	4	0

Table 4.8 Summary statistics for the self-concept questionnaire answers for "Taking pleasure in maths" for the tutees before and after the peer tutoring intervention.
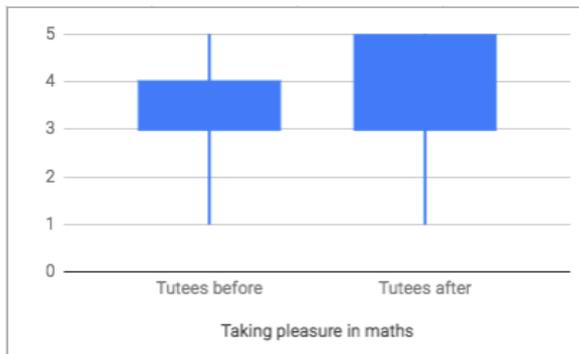
Diagram 4.7 Distribution of answers for the questions about "Taking Pleasure in Maths" before and after the peer tutoring intervention programme.

There was a change in the mean scores for taking pleasure in maths of 0.05 for the 12 tutees. Using a T-test for dependent means this change is not statistically significant. Of the 12 participants, only 2 changed their overall scores for the questions that tested taking pleasure in maths. Each was only by one or two points.

4.3.2 Mathematics self concept changes in tutors

The mean self concept scores for all but two individual questions in the pre-questionnaire were greater than 4, showing that the tutors already felt positive about maths in almost all areas before the intervention. As such I will not analyse each of the five self concept areas separately as I have done above for the tutees. In addition, although I calculated them, I will not refer to the mode and median in this discussion, as I do not think they are helpful, or add any more insight to the statistical analysis that just using the mean.

The high scores in all areas would be what I would expect as a professional for two reasons. Firstly the tutors all came from the top maths set, so by definition would be able in maths, but secondly, and more importantly, the tutors volunteered to take part in the

50

intervention, so I would have expected them to be students who enjoyed maths and felt positive about doing it. It would be unlikely, in my opinion, that a student who did not like maths would volunteer to do more of it.

The two questions that the tutors did not score highly in, those that had a mean score of less than 4, were questions 3 and 20. Question 3 was "The only maths that interests me is what will be in a test or exam, because it is the most important and what I have to know." On reflection it does not surprise me that the score for this question seem anomalistic compared to the others, with a mean score of 2.83. The original questionnaire was designed for use in a different country (Spain), and it would be my conjecture that this different context accounts for the difference. The accountability system for exam results in Spain is could be different to England, so teachers may be freer to vary the maths curriculum away from just the exam specifications. Unfortunately, the responses of the students in this case are probably also a reflection of the priorities of their teachers. I do not think it necessarily shows a reduced interest in maths, which was what the question was designed to test.

Question 20 was "I get anxious and I feel scared when the teacher asks me to solve a problem in front of the class". This question was designed to test whether students take pleasure in maths. As above, on reflection I am not surprised that this question scored unusually low compared to most of the rest, with a mean score of 3.00. In my professional opinion this low score may indicate a lack of confidence in speaking in front of peers, rather than a lack of pleasure in doing maths. I also wonder whether the score in this particular question was disproportionately skewed by my study being in an all girls

51

environment. As a teacher who has taught in both mixed and single sex school, it is generally true that girls are less confident than boys.

Incidentally, the scores of the tutees in questions 3 and 20 were amongst the lowest in both the pre and post-questionnaires, however they did not stand out as anomalies as other questions had almost as low scores. However, if the reasoning I have applied above is correct for the tutors then it would equally be the same for the tutees.

Area	Mean score in the pre-questionnaire	Mean score in the post-questionnaire	Change
Interest in maths	4.10	4.05	-0.05
(Perceived) Efficiency in maths	4.50	4.53	0.03
Motivation in maths	4.38	4.43	0.05
Attributing maths success or failure to chance	4.33	4.32	-0.02
Taking pleasure in maths	3.93	3.97	0.03

Table 4.9 Mean scores of answers to the mathematical self-concept questionnaire for the tutors before and after the peer tutoring intervention programme.

Table 4.9 above shows that even with the low scores of questions 3 and 20, the overall mean scores in the five areas were all still approximately 4. This means that broadly, for each question designed to test the areas, the tutors "agreed". The scores in the post-questionnaire were very similar, with small changes in each area. The questionnaires were conducted 9 weeks apart, so the students would not necessarily have remembered their original answers, and some variation would be expected. All students changed at least one of their responses, but no one individual student changed their answers by more than 4 points, in either the positive or negative direction. In conclusion, it is not possible to

52

say that the intervention resulted in an increase in self concept for the tutors, as they already seemed to have good self concept before the intervention started.

4.4 Correlation between changes in academic attainment and mathematical self concept

There was very little change in either mathematical self concept or the rate of academic progress for the tutors, so I will not undertake any further statistical analysis of a correlation between the two for the tutors.

It is difficult to measure the correlation for the tutees, as the increments of change for academic attainment are all so low. Students are only expected to make one sub-level of progress over two terms, so measuring academic progress over the course of the intervention which lasted one term only is somewhat problematic. In theory the progress should be 0.5 sub-levels, and although a decimal figure can be achieved when taking an average of all the students, in practice for each individual student they can only make integer sub-level of progress. The data showed that some students did indeed make 0 or 1 sub-levels of progress over the course of the intervention, and in addition some students made 2 sub-levels of progress. Diagram 4.8 below shows that there is very little correlation between the two variables. The Pearson's Product Moment Correlation Coefficient is -0.238, indicating no correlation (see appendix 14). Even if the academic progress was not in such large increments, I think it would be unlikely that there would be a positive correlation, based on the last data point which shows that the tutee who made the most academic progress did not experience any change at all in mathematical self concept.

Progress between the start and end of the intervention and
overall change in mathematical self concept
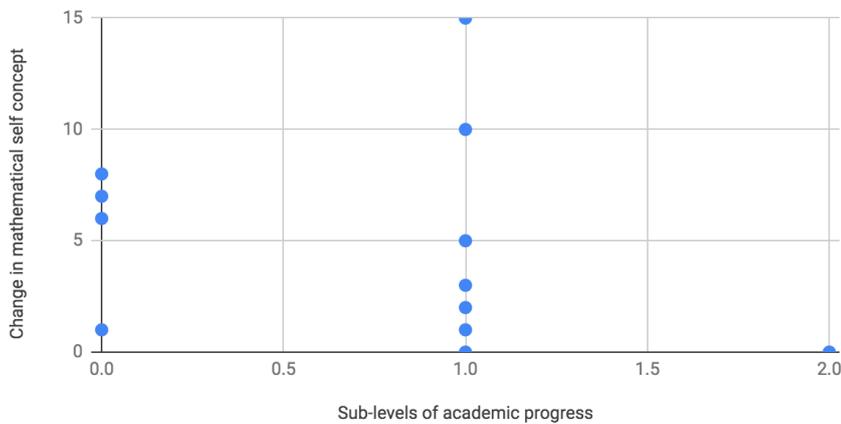
Diagram 4.8 A scatter graph to show the correlation between academic progress made by
the tutees and the change in their mathematical self concept.

4.5 Feedback on the intervention sessions

Following the intervention I undertook a short interview with the mathematics department

academic assistant, as she oversaw all of the intervention sessions. She reported that the

sessions generally ran very well, and made the following points:

- The students arrived on time and got started without very much prompting. Two

    twenty minute sessions per week seemed about right; not too long for the students

    to get bored, but enough to get a significant amount of work done.

- The workbooks were a good idea as it meant the sessions were very structured,

    with little time wasted looking for resources. This worked better than previous peer

    tutoring sessions she has overseen where older students helped younger students

    with homework, or whatever mathematics problems they wanted to bring along.

- The Year 10 tutors were very enthusiastic and seemed to relish their roles. They

    behaved maturely and were very encouraging to the Year 8 tutees. The academic

assistant felt that some of their positive attitude about maths might have been rubbing off on the younger students.

The last point in particular resonates with me, particularly as the data above on the change in mathematical self concept for the tutees bears this out. Could it be possible that as well as transmitting mathematical knowledge the Year 10 tutors also passed on some of their positive mathematical self concept? This is a question I cannot answer in this piece of research, but is very interesting to me as a professional.

5 Conclusion

5.1 Returning to the research questions

5.1.1 Does a peer tutoring programme improve the academic performance of the tutees?

The test data shows that the intervention did have a positive effect on the rate of academic progress of the tutees. This is in line with the vast majority of the literature I reviewed in chapter 1 which led me to choose peer tutoring as an intervention. It is difficult to make direct comparisons of this study with some of the earlier work on peer tutoring, as the research design differs. For example, Hartley (1977) was comparing different types of intervention with each other to measure their relative effectiveness, and others such as Devin-Sheehan et al (1976) were using peer tutoring instead of normal class teaching, rather than using peer tutoring as an additional intervention. Similarly Spörer and Brunstein (2009) were comparing peer tutoring with teacher instruction. However, my research does agree with the literature that peer tutoring helps tutees make academic progress.

The literature review in chapter 2 informed the organisational dimensions of the peer tutoring intervention programme in this research. All of the choices I made were a direct result of the information from the literature, with some influence from my own professional experience. Even the factors that I could not change i.e. single sex and disadvantaged tutees were reinforced in the literature as features of successful peer tutoring.

Most of the literature used to inform the organisational dimensions were meta-analyses, so took into account many studies with varying research designs, and in some cases either compared approaches or even attempted to give various factors effect size. I can neither attribute an effect size to any of the organisational dimensions in my research, nor compare whether one way of organising peer tutoring would be more effective than another, however I can say that my research does not contradict any of the literature as the tutees did make academic progress.

There was a comparison group in my experiment design, so the results can be compared with students who did not participate in the peer tutoring intervention programme, however it was a very small sample, and I did not control for other variables. For example the students came from maths sets with 5 different teachers, where they may have been making progress at different rates anyway. Furthermore, it is not possible to say whether the positive effect on academic progress would last if the same statistical analysis was carried out after another term. Ultimately, the school is measured on outcomes at GCSE, so to really test if this intervention had an effect on the progress of the tutees they would have to be followed all the way to the end of Year 11.

5.1.2 Does a peer tutoring programme improve the academic performance of the tutors?

The test data did not show that participating in the intervention had any effect on the tutors; they continued to make progress at a similarly fast rate as they had done before. Much of the more recent literature on peer tutoring (Topping, 2005 and Duran, 2005) indicated that peer tutoring can have a positive effect on the academic performance of the students who

act as tutors, however the outcome of this research does not reinforce this. A possible reason for this disagreement could be found in the explanations given by researchers for why they believe the tutors can find the tutoring process beneficial. Topping (2005) conjectures that the tutors make gains because they are constantly having to monitor the tutees, pick up misconceptions and reshape explanations. The material used for teaching in the peer tutoring intervention in this research was basic computational maths, at a skill level significantly below what the tutors would have had. Perhaps the "crystallisation" of knowledge that Topping refers to only happens when the tutors haven't already fully grasped a concept; in this case because the maths would have been so simple for them there was no more learning to be done.

The tutors as a group in this research were already some of the highest performing students in their cohort. This may be a useful point to note though for planning of any further intervention; it may be that selecting students as tutors for peer tutoring who have made the most academic progress so far is vitally important to its success. This conjecture would need to be investigated further in another study for validation.

5.1.3 Are there additional effects on the participants of peer tutoring, outside of academic gains?

The data gathered from the mathematical self concept questionnaires showed that there was a positive change in mathematical self concept for the tutees following the intervention. I did not however, gather any evidence to show that this positive change lasts beyond the immediate end of the intervention. I cannot attribute a cause and effect relationship from the intervention to the increased self concept for the tutees as I did not

undertake the same questionnaire with a control group. If I had given the questionnaire to the whole cohort of students in Year 8 then it would have been possible to make that comparison. It is impossible to say if there might have been some reason why the mathematical self concept of all Year 8 students increased over the time period the intervention was carried out in. However, the important point to note is that over the course of the intervention the tutees did not show a decrease in mathematical self concept, so the peer tutoring intervention programme was not detrimental.

The findings of this research agree with the literature that peer tutoring has a positive effect on mathematical self-concept for the tutors (Topping, 2005, Ginsburg-Block et al 2006, Alegre Ansuategui and Moliner Miravet, 2017). This reinforcement of the literature is less strong than in sections above where academic gains are discussed. This is because the methodology used in this research to measure mathematical self-concept was not the same as in the research referenced, although it was largely based on the work of Alegre Ansuategui and Moliner Miravet. As a researcher this methodology may not have been entirely robust, however as a practitioner I am satisfied that the students experienced a positive change in their outlook and attitude towards maths, which can only be a good thing, in my professional opinion and experience.

The tutors who participated in the peer tutoring intervention already showed high levels of mathematical self concept in the pre-test questionnaire. As such it was difficult to measure a positive change. However, as above, the important point to note is that over the course of the intervention the tutors did not show a decrease in mathematical self concept. If either

group had done so then it would call into question the success of the intervention programme, and make it questionable whether it could or should be used again.

5.1.4 Is there any correlation between students making academic progress and the additional effects?

I had intended to measure this for both tutors and tutees in my original research plan, however once I analysed the pre and post-test questionnaires for the Year 10 tutors it became evident that it would not be possible due to their minimal change in mathematical self concept. As such I could only undertake this analysis for the Year 8 tutees. Although in the previous sections I have shown that the tutees did on average experience better mathematical self concept following the intervention, and they made academic progress at an accelerated rate, the data did not show that there was any correlation between the two. One flaw in the methodology was that the increments the academic attainment was measured in were very large, compared to those the change in mathematical self concept was measured in, however even after taking that into account there is no evidence to suggest there is any correlation between these two variables.

This outcome of the research does not agree with what was suggested in the literature, particularly by Ginsburg-Block, Rohrbeck and Fantuzzo (2006), when it comes to a correlation between students who made academic gains, and gains in mathematical self concept as a result of the peer tutoring intervention programme. However, for the reasons outlined above regarding methodology I do not think there is enough evidence to actually say this research is contradictory to the literature.

5.2 Implications

This small scale research has shown that peer tutoring can be beneficial to students who have fallen behind, both in terms of raising academic attainment and improving mathematical self concept. This research did not gather any evidence to find out if these academic and self concept gains will last over the medium and long term for the participants. In a further study it would be interesting to find out if the increased rate of progress for the tutee participants remained the same, or dropped back to its previous level in the terms following completion of the intervention.

The intervention was relatively easy to organise in school, and low cost. Although it did require the time of a paid adult for two twenty minute sessions per week for eight weeks it was possible to facilitate this within the mathematics department with the academic assistant. In comparison to the alternative methods of intervention discussed in section 1.2 of the introduction it is very low cost.

This intervention could be viewed as a pilot study, and further tested with other students, both in mathematics and in other subjects. As the literature review showed, the organisational dimensions of the intervention can greatly influence its impact, so it cannot be assumed that the same type of intervention would work as effectively, if at all, with tutees with different characteristics (for example of a different age and/or disadvantaged status), or in different subjects. The success with different subject matter in a further intervention cannot be predicted, for example, asking peer tutors to teach analysis in English is clearly different to teaching basic arithmetic computation in mathematics.

My opinion as a school leader would be that my school, and indeed any school, would have very little to lose by trialling a peer tutoring programme such as the one undertaken in this research. The risks would be twofold, but I believe they are outweighed by the potential rewards. Firstly, the greatest risk a school may feel they are taking is that the intervention may have a detrimental effect on the tutees or the tutors. From the literature review, and my own research this is highly unlikely, if the intervention is adequately supervised. Secondly, any intervention costs time, energy and money in planning, setting up and carrying out, so a school is risking this being wasted if the intervention has no effect. I would argue that this is mitigated by the very low cost of this intervention.

Although I cannot say as a result of this research that peer tutoring unequivocally works, and is transferable to all contexts, my findings do suggest that it is likely to work for other students in other schools, and could be a helpful intervention for teachers and leaders to enable students who have fallen behind to catch up. This could form part of a wider strategy to help close the attainment gap for pupil premium students, therefore being an agent of social mobility.

References

Alegre Ansuategui, F. J., & Moliner Miravet, L. (2017). Emotional and cognitive effects of peer tutoring among secondary school mathematics students. *International Journal of mathematical education in science and technology*, *48*(8), 1185-1205.

Cohen, P. A., Kulik, J. A., & Kulik, C. L. C. (1982). Educational outcomes of tutoring: A meta-analysis of findings. *American educational research journal*, *19*(2), 237-248.

Devin-Sheehan, L., Feldman, R., & Allen, V. (1976). Research on Children Tutoring Children: A Critical Review. *Review of Educational Research, 46*(3), 355-385.

Duran, D., & Monereo, C. (2005). Styles and sequences of cooperative interaction in fixed and reciprocal peer tutoring. *Learning and Instruction*, *15*(3), 179-199.

Gil Ignacio, N., Guerrero Barona, E., & Blanco Nieto, L. (2006). El dominio afectivo en el aprendizaje de las Matemáticas.

Ginsburg-Block, M. D., Rohrbeck, C. A., & Fantuzzo, J. W. (2006). A meta-analytic review of social, self-concept, and behavioral outcomes of peer-assisted learning. *Journal of Educational Psychology*, *98*(4), 732.

Hartley, S. S. (1977). *Meta-analysis of the effects of individually paced instruction in mathematics* (Doctoral dissertation, University of Colorado at Boulder).

Leung, K. C. (2015). Preliminary empirical model of crucial determinants of best practice for peer tutoring on academic achievement. *Journal of Educational Psychology*, *107*(2), 558.

Organisation for Economic Co-operation and Development (OECD). (2013). *PISA 2012 results: ready to learn: students' engagement, drive and self-beliefs (volume III): preliminary version*. OECD, Paris, France.

Peer tutoring | Toolkit Strand. (2019). Retrieved 20 August 2019, from https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/peer-tutoring/

Spörer, N., & Brunstein, J. C. (2009). Fostering the reading comprehension of secondary school students through peer-assisted learning: Effects on strategy knowledge, strategy use, and task performance. *Contemporary Educational Psychology*, *34*(4), 289-297.

Stenhoff, D. M., & Lignugaris/Kraft, B. (2007). A review of the effects of peer tutoring on students with mild disabilities in secondary settings. *Exceptional children*, *74*(1),

8-30.Topping, K. J., & Ehly, S. W. (2001). Peer assisted learning: A framework for consultation. *Journal of Educational and Psychological Consultation*, *12*(2), 113-132.

Topping, K. J. (2005). Trends in peer learning. *Educational psychology*, *25*(6), 631-645.

Topping, K. J., Miller, D., Murray, P., Henderson, S., Fortuna, C., & Conlin, N. (2011). Outcomes in a randomised controlled trial of mathematics tutoring. *Educational Research*, *53*(1), 51-63.

Appendix 1 - Original questionnaire in Spanish

NÚMERO DE HERMANOS (incluido el/a alumno/a): **INSTRUCCIONES**

Para contestar el cuestionario has de marcar con una **X** la opción de respuesta que consideres más oportuna. Las escalas de valores son las siguientes:

Muy de acuerdo
De acuerdo
En desacuerdo
Muy en desacuerdo

1. Las matemáticas son útiles y necesarias en todos los ámbitos de la vida

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

2. Las matemáticas son difíciles, aburridas y alejadas de la realidad

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

3. En matemáticas es fundamental aprenderse de memoria los conceptos, fórmulas y reglas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

4. Casi todos los problemas de matemáticas se resuelven normalmente en pocos minutos, si se conoce la fórmula, regla o procedimiento que ha explicado el profesor o que figura en el libro de texto

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

5. Las únicas matemáticas que me interesan son las que entran en el examen, porque son las más importantes y las que tengo que conocer

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

6. La mejor forma de aprender matemáticas es a través del estudio individual

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

7. El resultado al que llego tras intentar resolver un problema es más importante que el proceso que he seguido

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

8. Sabiendo resolver los problemas que propone el profesor en clase, es posible solucionar otros del mismo tipo si sólo les han cambiado los datos

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

9. Las destrezas o habilidades que utilizo en clase para resolver problemas no tienen nada que ver con las que utilizo para resolver problemas en la vida cotidiana

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

10. Busco distintas maneras y métodos para resolver un problema

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

11. Aprendo mucho inventándome nuevos problemas

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

El dominio afectivo en el aprendizaje de las Matemáticas

12. El gusto por las matemáticas influye a la hora de escoger una determinada modalidad de bachillerato en la que estén o no presentes

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

13. El ser buen/a alumno/a en matemáticas (sacar buenas notas, tener buena actitud) te hace sentirse más valorado y admirado por los compañeros

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

14. Si no comprendo las matemáticas, difícilmente podré asimilar y dominar otras asignaturas relacionadas con ella (como física, química, etc.)

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

15. Mi rendimiento en matemáticas depende en gran medida de la actitud del/a profesor/a hacia mí

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

16. Cuando dedico más tiempo de estudio a las matemáticas obtengo mejores resultados en la resolución de problemas

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

17. Cuando resuelvo un problema suelo dudar de si el resultado es correcto

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

18. Tengo confianza en mí mismo/a cuando me enfrento a los problemas de matemáticas

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

19. Me considero muy capaz y hábil en matemáticas

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

20. Estoy calmado/a y tranquilo/a cuando resuelvo problemas de matemáticas

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

21. Cuando me esfuerzo en la resolución de un problema suelo dar con el resultado correcto

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

22. La suerte influye a la hora de resolver con éxito un problema de matemáticas

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

23. En clase de matemáticas los/as profesores/as emplean gran variedad de medios y ejemplos prácticos que me permiten relacionar las matemáticas con situaciones de mi vida diaria

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

24. Cuando los/as profesores/as nos proponen trabajos en grupo suele haber un alto nivel de interés y participación en clase

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

25. Los profesores/as de matemáticas están siempre dispuestos/as a prestar ayuda y a aclarar las dudas y dificultades que surjan durante la clase

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

26. Para mis profesores/as de matemáticas soy un/a buen/a alumno/a

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

27. Mis relaciones con los/as profesores/as de matemáticas son satisfactorias

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

28. Los/as buenos/as profesores/as que explican con bastante claridad y entusiasmo y son agradables hacen que gusten las matemáticas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

29. Los/as profesores/as de matemáticas se interesan por mi evolución y rendimiento en la materia

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

30. En clase de matemáticas los/as profesores/as valoran mi esfuerzo y reconocen mi trabajo diario en la asignatura

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

31. Alguno de mis padres espera de mí buenos resultados en matemáticas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

32. Las matemáticas que nos enseñan en el instituto no les interesan a mis padres

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

33. Alguno de mis padres era bastante bueno/a resolviendo problemas de matemáticas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

34. Alguno de mis padres me anima y ayuda con los problemas de matemáticas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

35. Mis amigos/as pasan de las matemáticas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

36. Las matemáticas son importantes porque las profesiones más remuneradas económicamente están relacionadas con ellas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

37. La gente a la que le gustan las matemáticas suelen ser un poco raras

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

38. El aumentar mis conocimientos matemáticos me hará sentir una persona competente en la sociedad

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

39. Las matemáticas son para cabezas inteligentes y creativas

   Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

40. Dominar las matemáticas me permitirá tener éxito en mis estudios posteriores

69

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

41. La gente que es buena en matemáticas no tiene que gastar tiempo pensando cómo resolver un problema

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

42. Las clases de matemáticas se me hacen eternas, son muy pesadas, no estoy a gusto y siento deseos de salir corriendo

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

43. Disfruto los días que no tenemos clases de matemáticas porque no me interesan ni me atraen

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

44. Ante un problema complicado suelo darme por vencido fácilmente

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

45. Cuando me enfrento a un problema experimento mucha curiosidad por conocer la solución

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

46. Me angustio y siento miedo cuando el profesor me propone "por sorpresa" que resuelva un problema

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

47. Cuando resuelvo problemas en grupo tengo más seguridad en mí mismo/a

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

48. Cuando me atasco o bloqueo en la resolución de un problema empiezo a sentirme inseguro, desesperado, nervioso,...

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

49. Si no encuentro la solución de un problema tengo la sensación de haber fracasado y de haber perdido el tiempo

70

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

50. Me provoca gran satisfacción llegar a resolver con éxito un problema matemático

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

51. Cuando fracasan mis intentos por resolver un problema lo intento de nuevo

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

52. La resolución de un problema exige esfuerzo, perseverancia y paciencia

Muy de acuerdo De acuerdo En desacuerdo   Muy en desacuerdo

Appendix 2 - Original questionnaire translated into English

Strongly agree
In agreement
In disagreement
Strongly disagree

1. Mathematics is useful and necessary in all areas of life

   Strongly Agree Agree Disagree Strongly Disagree

2. Mathematics is difficult, boring and far from reality

   Strongly Agree Agree Disagree Strongly Disagree

3. In mathematics it is essential to memorize the concepts, formulas and rules

   Strongly Agree Agree Disagree Strongly Disagree

4. Almost all math problems are solved normally in a few minutes, if you know the formula, rule or procedure that has been explained by the teacher or that appears in the textbook

   Strongly Agree Agree Disagree Strongly Disagree

5. The only mathematics that interest me are those that enter the exam, because they are the most important and the ones that I have to know

   Strongly Agree Agree Disagree Strongly Disagree

6. The best way to learn mathematics is through individual study

   Strongly Agree Agree Disagree Strongly Disagree

7. The result I get after trying to solve a problem is more important than the process I followed

   Strongly Agree Agree Disagree Strongly Disagree

8. Knowing how to solve the problems proposed by the teacher in class, it is possible to solve other problems of the same type if only the data have changed

   Strongly Agree Agree Disagree Strongly Disagree

9. The skills or abilities I use in class to solve problems have nothing to do with the skills I use to solve problems in everyday life

   Strongly Agree Agree Disagree Strongly Disagree

10. I look for different ways and methods to solve a problem

   Strongly Agree Agree Disagree Strongly Disagree

11. I learn a lot by inventing new problems

   Strongly Agree Agree Disagree Strongly Disagree

12. The taste for mathematics influences when choosing a certain type of baccalaureate in which they are present or not

   Strongly Agree Agree Disagree Strongly Disagree

13. Being a good student in mathematics (getting good grades, having a good attitude) makes you feel more valued and admired by classmates

   Strongly Agree Agree Disagree Strongly Disagree

14. If I do not understand mathematics, I can hardly assimilate and master other subjects related to it (such as physics, chemistry, etc.)

   Strongly Agree Agree Disagree Strongly Disagree

15. My performance in mathematics depends to a large extent on the attitude of the teacher towards me

   Strongly Agree Agree Disagree Strongly Disagree

16. When I spend more time studying mathematics I get better results in solving problems

   Strongly Agree Agree Disagree Strongly Disagree

17. When I solve a problem I usually doubt whether the result is correct

   Strongly Agree Agree Disagree Strongly Disagree

18. I have confidence in myself when faced with math problems

Strongly Agree Agree Disagree Strongly Disagree

19. I consider myself very capable and skilled in mathematics

Strongly Agree Agree Disagree Strongly Disagree

20. I am calm and calm when I solve math problems

Strongly Agree Agree Disagree Strongly Disagree

21. When I try to solve a problem, I usually find the correct result

Strongly Agree Agree Disagree Strongly Disagree

22. Luck influences when solving a math problem successfully

Strongly Agree Agree Disagree Strongly Disagree

23. In math class teachers use a variety of media and practical examples that allow me to relate mathematics to situations in my daily life

Strongly Agree Agree Disagree Strongly Disagree

24. When the teachers propose group work, there is usually a high level of interest and participation in class

Strongly Agree Agree Disagree Strongly Disagree

25. Mathematics teachers are always willing to help and clarify doubts and difficulties that arise during class

Strongly Agree Agree Disagree Strongly Disagree

26. For my teachers of mathematics I am a good student

Strongly Agree Agree Disagree Strongly Disagree

27. My relationships with the mathematics teachers are satisfactory

Strongly Agree Agree Disagree Strongly Disagree

28. The good teachers who explain with enough clarity and enthusiasm and are pleasant make them like mathematics

   Strongly Agree Agree Disagree Strongly Disagree

29. Mathematics teachers are interested in my evolution and performance in the subject

   Strongly Agree Agree Disagree Strongly Disagree

30. In math class the teachers value my effort and recognize my daily work in the subject

   Strongly Agree Agree Disagree Strongly Disagree

31. Some of my parents expect good results in mathematics from me

   Strongly Agree Agree Disagree Strongly Disagree

32. The mathematics that we teach in high school does not interest my parents

   Strongly Agree Agree Disagree Strongly Disagree

33. Some of my parents were pretty good at solving math problems

   Strongly Agree Agree Disagree Strongly Disagree

34. Some of my parents encourage me and help with math problems

   Strongly Agree Agree Disagree Strongly Disagree

35. My friends pass from mathematics

   Strongly Agree Agree Disagree Strongly Disagree

36. Mathematics is important because the most economically remunerated professions are related to them

   Strongly Agree Agree Disagree Strongly Disagree

37. People who like maths are usually a little weird

   Strongly Agree Agree Disagree Strongly Disagree

38. Increasing my mathematical knowledge will make me feel a competent person in society

   Strongly Agree Agree Disagree Strongly Disagree

39. Mathematics is for intelligent and creative heads

   Strongly Agree Agree Disagree Strongly Disagree

40. Mastering the mathematics will allow me to be successful in my later studies

   Strongly Agree Agree Disagree Strongly Disagree

41. People who are good at math do not have to spend time thinking about how to solve a problem

   Strongly Agree Agree Disagree Strongly Disagree

42. Mathematics classes are eternal, they are very heavy, I'm not comfortable and I feel like running

   Strongly Agree Agree Disagree Strongly Disagree

43. I enjoy the days that we do not have math classes because they do not interest me or attract me

   Strongly Agree Agree Disagree Strongly Disagree

44. When faced with a complicated problem, I easily give up

   Strongly Agree Agree Disagree Strongly Disagree

45. When I am faced with a problem I am very curious to know the solution

   Strongly Agree Agree Disagree Strongly Disagree

46. I get anxious and I feel scared when the teacher proposes "by surprise" to solve a problem

   Strongly Agree Agree Disagree Strongly Disagree

47. When I solve group problems I have more self-confidence

76

Strongly Agree Agree Disagree Strongly Disagree

48. When I get stuck or blocked in the resolution of a problem I start to feel insecure, desperate, nervous, ...

Strongly Agree Agree Disagree Strongly Disagree

49. If I can not find the solution to a problem, I have the feeling that I have failed and that I have wasted my time

Strongly Agree Agree Disagree Strongly Disagree

50. It gives me great satisfaction to successfully solve a mathematical problem

Strongly Agree Agree Disagree Strongly Disagree

51. When my attempts to solve a problem fail, I try again

Strongly Agree Agree Disagree Strongly Disagree

52. Solving a problem requires effort, perseverance and patience

Strongly Agree Agree Disagree Strongly Disagree

Appendix 3 - Edited questionnaire

<u>Score of 5 is underlined and shows someone with greater self-concept</u>

1. Mathematics is useful and necessary in all areas of life

 <u>Strongly Agree</u> Agree Disagree Strongly Disagree

2. Mathematics is difficult, boring and not needed in the real world

 Strongly Agree Agree Disagree <u>Strongly Disagree</u>

3. The only maths that interests me is what will be in a test or exam, because it is the most important and what I have to know

 Strongly Agree Agree Disagree <u>Strongly Disagree</u>

4. If I know how to solve a problem the teacher showed us in class, I will be able to solve other problems of the same type

 <u>Strongly Agree</u> Agree Disagree Strongly Disagree

5. The skills I use in class to solve maths problems have nothing to do with the skills I use to solve problems in everyday life

 Strongly Agree Agree Disagree <u>Strongly Disagree</u>

6. I look for different ways and methods to solve a maths problem

 <u>Strongly Agree</u> Agree Disagree Strongly Disagree

7. I learn a lot by inventing new maths problems

 <u>Strongly Agree</u> Agree Disagree Strongly Disagree

8. My performance in maths depends to a large extent on the attitude of the teacher towards me

 Strongly Agree Agree Disagree <u>Strongly Disagree</u>

9. When I spend more time studying maths I get better at solving problems

 <u>Strongly Agree</u> Agree Disagree Strongly Disagree

10. I have confidence in myself when faced with math problems

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

11. I consider myself very capable and skilled in mathematics

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

12. I am calm and relaxed when I solve math problems

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

13. Luck influences if I can solve a maths problem successfully

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

14. Maths is only for intelligent people

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

15. People who are good at maths do not have to spend time thinking about how to solve a problem

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

16. Maths classes go on for a long time, I'm not comfortable and I feel like running away

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

17. I enjoy the days that we do not have maths classes because they do not interest me

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

18. When faced with a complicated problem, I easily give up

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

19. When I am faced with a problem I am very curious to know the solution

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

20. I get anxious and I feel scared when the teacher asks me to solve a problem in front of the class

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

21. When I get stuck when trying to solve a problem I start to feel insecure, desperate and nervous

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

22. If I can not find the solution to a problem, I get the feeling that I have failed and that I have wasted my time

  Strongly Agree Agree Disagree <u>Strongly Disagree</u>

23. It gives me great satisfaction to successfully solve a mathematical problem

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

24. When my attempts to solve a problem fail, I try again

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

25. I believe I can solve even difficult maths problems if I really try

  <u>Strongly Agree</u> Agree Disagree Strongly Disagree

Appendix 4 - Students copy of the questionnaire for the pilot test

1. Mathematics is useful and necessary in all areas of life

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

2. Mathematics is difficult, boring and not needed in the real world

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

3. The only maths that interests me is what will be in a test or exam, because it is the most important and what I have to know

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

4. If I know how to solve a problem the teacher showed us in class, I will be able to solve other problems of the same type

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

5. The skills I use in class to solve maths problems have nothing to do with the skills I use to solve problems in everyday life

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

81

6. I look for different ways and methods to solve a maths problem

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

7. I learn a lot by inventing new maths problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

8. My performance in maths depends to a large extent on the attitude of the teacher towards me

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

9. When I spend more time studying maths I get better at solving problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

10. I have confidence in myself when faced with math problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

11. I consider myself very capable and skilled in mathematics

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

12. I am calm and relaxed when I solve math problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

13. Luck influences if I can solve a maths problem successfully

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

14. Maths is only for intelligent people

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

15. People who are good at maths do not have to spend time thinking about how to solve a problem

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

16. Maths classes go on for a long time, I'm not comfortable and I feel like running away

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

17. I enjoy the days that we do not have maths classes because they do not interest me

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. When faced with a complicated problem, I easily give up

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

19. When I am faced with a problem I am very curious to know the solution

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

20. I get anxious and I feel scared when the teacher asks me to solve a problem in front of the class

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

21. When I get stuck when trying to solve a problem I start to feel insecure, desperate and nervous

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

22. If I can not find the solution to a problem, I get the feeling that I have failed and that I have wasted my time

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

23. It gives me great satisfaction to successfully solve a mathematical problem

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

24. When my attempts to solve a problem fail, I try again

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

25. I believe I can solve even difficult maths problems if I really try

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

Appendix 5- Pilot survey questions

Thank you for agreeing to take part in this pilot study.
You do not need to write your name on any part of this survey.
Your responses will remain anonymous.
Your comments will be used to help the researcher make the survey better for use with other students. Your actual responses to the survey will not be used.
Please answer the questions below and give reasons for your answers if you can.

Start time		Finish time	

1) Were the instructions on how to complete the survey clear?

2) Were any questions unclear or confusing? If so which ones?

3) Were there any questions you didn't want to answer? If so which ones? Why?

4) Do you think anything important has been left out about how you feel about learning maths?

5) Was the layout of the survey clear and easy to read?

6) Any other comments?

Appendix 6 - Pilot survey responses

No.	Time (mins)	1) Were the instructions on how to complete the survey clear?	2) Were any questions unclear or confusing? If so which ones?	3) Were there any questions you didn't want to answer? If so which ones? Why?	4) Do you think anything important has been left out about how you feel about learning maths?	5) Was the layout of the survey clear and easy to read?	6) Any other comments?
1	11	Y	N	N	N	Y	N
2	10	Y	13	N	N	Y	N
3	7	Y	8	N	Do you enjoy maths?	Y	N
4	10	Y	N	N	Confidence, studying, failing	Y	N
5	-	Y	8 and 13	8 - didn't make sense	N	-	-
6	9	Y	4, 13, 21	N	Do you like maths?	Y	N
7	7	Y	N	N	N	Y	N
8	10	Y	3	N	N	Y	N
9	7	Didn't know to circle or tick the boxes	I found it quite confusing	11 & 15	N	Y	N
10	10	Y	8	16, 20, 21	N	Yes, but didn't know whether to tick or circle	I had enough time
11	17	Y	7 and 13 didn't really understand	14 because I feel like it is true but I know it's not	N	Y	N
12	10	Y	N	N	N	Y	N
13	10	Y	N	N	N	Y	N
14	7	-	16	N	N	Boxes too small	Could add a sometimes box
15	9	Some were confusing	13 and 23	N	N	Make the boxes bigger	Add a sometimes box because I had to tick two boxes (q24)
16	12	-	-	-	-	-	Didn't get questions 8 and 13 and it's a bit too long, 15 or 20 questions would be better
17	5	Y	Y	N	N	Make the writing bigger and bolder	-
18	6	-	-	-	-	-	4 doesn't really make sense
19	10	Y	8	N	N	Y	The questions were quite long
20	9	Y	N	3	N	Y	I didn't know whether to tick or circle
21	-	Y	N	N	N	Y	N
22	7	Y	N	N	N	Y	Good and clear
23	14	Y	N	N	N	Y	Don't include question 14
Max	17						

Appendix 7 - Questionnaire cover page

Thank you for agreeing to take part in this study. Please do not write your name on any part of it.

If you do not want to take part in this questionnaire you do not have to. Please let the researcher know if you do not want to take part.

The purpose of the study
I am trying to find out how students feel about their own ability in maths.

Confidentiality and anonymity
You have been assigned a number identifier so that your answers cannot be associated with you. Your answers will not be discussed with anyone. Every effort will be made to ensure that individual students will not be identifiable from the final report.

Security of data
All electronic data will be stored on a secure server and password protected. Only the researcher will know the password. All paper based data will be locked in a secure filing cabinet in a lockable office with only the researcher having the keys to both.

Transparency
A copy of the final report will be made available to you if you wish.

Please try to answer every question honestly. Try not to miss any questions out. For questions where you have to give a reason write down as much as you can.

There is no time limit to filling this survey in.

Appendix 8 - Final questionnaire
Please put a tick in the box that best represents your opinion.
Only tick one box per question.

1. Mathematics is useful and necessary in all areas of life

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

2. Mathematics is difficult, boring and not needed in the real world

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

3. The only maths that interests me is what will be in a test or exam, because it is the most important and what I have to know

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

4. If I know how to solve a problem the teacher showed us in class, I will be able to solve other problems of the same type

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

5. The skills I use in class to solve maths problems have nothing to do with the skills I use to solve problems in everyday life

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

6. I look for different ways and methods to solve a maths problem

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

7. I learn a lot by inventing new maths problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

8. If I do well in maths it is because the teacher likes me

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

9. When I spend more time studying maths I get better at solving problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

10. I have confidence in myself when faced with math problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

11. I consider myself very capable and skilled in mathematics

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

12. I am calm and relaxed when I solve math problems

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

13. When I solve a maths problem successfully it is more down to luck than my own skill

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

14. Maths is only for intelligent people

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

15. People who are good at maths do not have to spend time thinking about how to solve a problem

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

16. Maths classes go on for a long time, I'm not comfortable and I feel like running away

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

17. I enjoy the days that we do not have maths classes because they do not interest me

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. When faced with a complicated problem, I easily give up

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

19. When I am faced with a problem I am very curious to know the solution

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

20. I get anxious and I feel scared when the teacher asks me to solve a problem in front of the class

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

21. When I get stuck when trying to solve a problem I start to feel insecure, desperate and nervous

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

22. If I can not find the solution to a problem, I get the feeling that I have failed and that I have wasted my time

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

23. It gives me great satisfaction to successfully solve a mathematical problem

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

24. When my attempts to solve a problem fail, I try again

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

25. I believe I can solve even difficult maths problems if I really try

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
☐	☐	☐	☐	☐

Appendix 9 - Signed permission letter from the Headteacher

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: +44(0)1865 274024   Fax: +44(0)1865 274027
general-enquiries@education.ox.ac.uk   www.education.ox.ac.uk

Director Professor Jo-Anne Baird

Mrs Anne Davis

4th January 2019

Dear Mrs Davis,

I am writing to enquire about conducting research in school this academic year. As you know, I am studying for the Master's in Learning and Teaching at Oxford University, supervised by Dr Nick Andrews. In my final research project "A peer tutoring program for year 8 pupil premium students in mathematics" I will explore the effects of peer tutoring on academic and non-academic outcomes on both the tutors and tutees.

The research will take place in a tutor time program of peer tutoring for one term. To measure the academic gains I will use the end of term test data already planned to be administered by the maths department so that the students involved in the research do not have to sit any additional tests. To measure the non-academic gains I will conduct short questionnaires with the tutors and tutees at the beginning and end of the research. The questions will be about motivation levels and self-concept in maths. I hope to conduct this research in the Spring term.

By participating in the research, the school would be contributing to a project that will deepen our understanding of cost-effective interventions in mathematics that can contribute to closing the attainment gap for disadvantaged students.

Oxford University has strict ethical procedures on conducting ethical research, consistent with current British Educational Research Association guidelines. The University also recognises, however, that my study is a piece of practitioner research, and that schools already operate with the highest ethical standards. Therefore only your formal consent as headteacher is necessary, and not that of individual parents or staff. However, throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teacher and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor and me, and only used for academic purposes. It will be kept for as long as it has academic value.

If you are happy for me to proceed with this study, please confirm that using the attached reply form. If you have any concerns or need more information about what is involved, please contact me or my supervisor.

94

Further, if you have any questions about this ethics process at any time, please contact the chair of the department's research ethics committee, though: research.office@education.ox.ac.uk

I look forward to hearing from you.

Yours sincerely,

A peer tutoring program for year 8 pupil premium students in mathematics

University of Oxford, Department of Education

- We would like to find out more about this project.

- We would like to take part in this project.

- We do not wish to participate in this project.
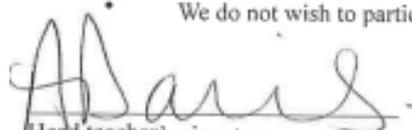
Head teacher's signature

Please return this form to me.

Thank you for your help.

Appendix 10 - Curec approval

A peer tutoring program for year 8 pupil premium students in mathematics

This is to <u>confirm</u> the above application has been considered on behalf of the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to DREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly, approval has been granted.

If your research involves participants whose ability to give free and informed consent is in question (this includes those under 18 and vulnerable adults), then it is advisable to read the following NSPCC professional reporting requirements for cases of suspected abuse <u>http://www.nspcc.org.uk/globalassets/documents/information-service/factsheet-child-abuse-reporting-requirements-professionals.pdf</u>

Should there be any subsequent changes to the project which raise ethical issues not covered in the original application you should submit details to <u>research.office@education.ox.ac.uk</u> for consideration.

Good luck with your research study.

Sincerely,
With kind regards,

Liam
Dr LF Gearon
Chair DREC
Department of Education, University of Oxford

Appendix 11 - Academic test data for Year 8 students

Participant number	Pupil Premium Indicator	KS2 data from SATs	Maths Attainment Autumn Yr8	Sub-levels progress from KS2	Maths Attain Spring Yr8	Progress between the start and end of the intervention
1	Y	2M	2M	0	2M	0
2	Y	2S	2S	0	2M	1
3	Y	2M	2M	0	3D	1
4	Y	2M	3D	1	3D	0
5	Y	2S	2M	1	3D	1
6	Y	3D	3S	1	3M	1
7	Y	2D	2S	1	2S	0
8	Y	2S	2M	1	3D	1
9	Y	2D	2S	1	2S	0
10	Y	2D	2S	1	2M	1
11	Y	2M	3D	1	3S	1
12	Y	2S	2M	1	3S	2
	Y	2M	2M	0	4D	1
	Y	3D	3M	2	4D	1
	Y	2S	3D	2	3S	1
	Y	2M	3S	2	3M	1
	Y	1M	2S	2	2M	1
	Y	1D	1M	2	1M	1
	Y	3S	3S	0	4S	0
	Y	1D	1M	2	2D	1
	Y	3D	3D	0	4D	1
	Y	1S	1S	0	2D	0
	Y	2S	3D	2	3S	1
	Y	2M	3S	2	3M	1
	Y	2S	3D	2	3D	0
	Y	2S	3D	2	3S	1
	Y	2M	3S	2	3M	1
	Y	2M	3S	2	3S	0
	Y	1D	1M	2	2D	1
	Y	1M	2S	2	2M	1

	Y	1M	2S	2	2M	1
		EntryD	2M	8	3D	1
		3D	3M	2	4D	1
		3D	3M	2	4D	1
		2D	2D	0	2S	1
		2S	3D	2	3D	0
		2M	3D	1	3S	1
		3D	4D	3	4D	0
		2S	2M	1	3D	1
		2M	3S	2	3M	1
		2M	3M	3	4D	1
		2D	2S	1	2M	1
		2M	3D	1	3D	1
		2S	3S	3	3M	1
		2M	3D	1	3S	1
		3D	2S	-2	2M	1
		1S	2D	2	2M	2
		3D	4D	3	4S	1
		2S	3D	2	3D	0
		3D	4D	3	4D	0
		2S	2S	0	2S	0
		2M	3S	2	3D	-1
		2M	3S	2	3M	1
		2M	3D	1	3M	2
		3D	4D	3	4D	0
		EntryD	3M	11	4D	1
		2S	3D	2	3S	1
		1S	1M	1	2D	1
		2M	3S	2	3M	1
		1S	1M	1	1M	0
		EntryD	3D	9	3S	1
		2M	3D	1	3S	1
		2M	3S	2	3M	1
		3D	4S	4	4S	0
		2M	2D	-2	2S	1

98

		3D	4D	3	4D	0
		3D	3M	2	3M	0
		3D	3M	2	3M	0
		2M	3D	1	3S	1
		2S	3D	2	3D	0
		2S	3D	2	3S	1
		2M	3D	1	3M	2
		2M	3D	1	3D	0
		2D	2D	0	2M	2
		3D	4D	3	4S	1
		1M	2D	1	2S	1
		3M	4M	3	5D	1
		2M	2M	0	3S	2
		2M	3S	2	3M	1
		2M	4D	4	4D	0
		2S	2S	0	2M	1
		3D	4D	3	5D	3
		2S	3D	2	3S	1
		2M	3S	2	3M	1
		2S	3D	2	3S	1
		2M	3S	2	3M	1
		3D	3D	0	3M	2
		2M	3M	3	3M	0
		2S	3D	2	3S	1
		2M	3D	1	3S	1
		2M	3M	3	4D	1
		2D	2M	2	3D	1
		2S	2M	1	3D	1
		1M	2S	2	2M	1
		2M	3S	2	3S	0
		3M	4S	2	5D	2
		2S	3D	2	3S	1
		2M	2M	0	2M	0
		2M	3M	3	3M	0
		3M	4M	3	4M	0

		3D	3S	1	4D	2
		2M	3S	2	3S	0
		1M	2D	1	2M	2
		EntryD	2D	6	2S	1
		2M	3M	3	4S	2
		2M	3S	2	3M	1
		2S	3D	2	3D	0
		3M	4S	2	5D	2
		EntryM	1M	3	1M	0
		2M	3D	1	3D	0
		2M	3S	2	4S	3
		2M	3D	1	3M	2
		2S	3D	2	3D	0
		2M	3D	1	3S	1
		2S	3D	2	3S	1
		2M	2M	0	3D	1
		2S	2M	1	2M	0
		3D	3M	2	4S	2
		2M	3M	3	4D	1
		3D	3S	1	3M	1
		2M	3M	3	3M	0
		3D	3S	1	4D	2
		3D	3D	0	4D	3
		2M	3M	3	3M	0
		1M	2S	2	2M	1
		2M	3S	2	3S	0
		2S	3D	2	3S	1
		2M	3D	1	3M	2
		3D	3M	2	4D	1
		1M	2S	2	2S	0
		EntryD	2S	7	2M	1
		EntryD	2M	8	2M	0
		3D	3M	2	4S	2
		3D	2M	-1	3D	1
		3D	4S	4	4S	0

		3D	3S	1	3M	1
		2D	2M	2	3D	1
		2M	3S	2	3S	0
		2M	3S	2	3S	0
		3D	4D	3	4D	0
		2M	3M	3	4D	1
		2M	3S	2	4S	3
		2S	2M	1	2M	0
		2D	3S	4	4D	2

101

Appendix 12 - Academic test data for Year 10 students

Participant number	Pupil Premium Indicator	Maths KS2 New KS2	Maths New Attain Sum2 Sum1 Yr9	Progress over KS3	Maths New Attain Aut2 Aut2 Yr10	Progress in 1st term of Year 10	Maths New Attain Spr2 Spr2 Yr10	Progress in 2nd term of Year 10 (intervention took place)
12		3S	5S	6	6S	3	6M	1
11		3D	4S	4	4D	-1	4M	2
10		3D	4M	5	5S	2	6D	2
9		2M	5D	7	5M	2	6D	1
8		2S	3M	4	4D	1	4S	1
7		3S	5S	6	6D	2	6S	1
6		3S	5S	6	6D	2	6S	1
5		3S	5D	5	6D	3	6S	1
4		2M	4M	6	5M	3	6D	1
3		3S	4S	3	4S	0	5M	4
2		3D	4M	5	4S	-1	5S	3
1		3S	4S	3	4M	1	5S	2
	Y	EntryD	4M	14	5M	3	6D	1
	Y	EntryD	4M	14	5M	3	6D	1
	Y	2D	3S	4	3S	0	3M	1
	Y	1S	2D	2	2S	1	2M	1
	Y	3D	4D	3	4D	0	4S	1
	Y	2M	4M	6	5D	1	5M	2
	Y	2S	3D	2	3D	0	3S	1
	Y	2D	3S	4	3S	0	3M	1
	Y	1D	2D	3	2D	0	2M	2
	Y	1S	3S	6	3S	0	3S	0
	Y	2S	3S	3	3S	0	3M	1
	Y	2S	2S	0	3D	2	2M	-1
	Y	2S	3M	4	3M	0	3M	0
	Y	2S	3D	2	2M	-1	2M	0
	Y	2S	3S	3	3M	1	3M	0
	Y	1S	2M	4	3D	1	3D	0
	Y	3S	3M	1	3M	0	4D	1
	Y	2S	3D	2	3S	1	3M	1
	Y	2M	4D	4	3M	-1	4S	2
	Y	2S	3S	3	3S	0	3M	1

	Y	2S	3S	3	2M	-2	3S	2
	Y	3S	4M	4	4D	-2	3M	-1
	Y	3D	3S	1	3M	1	4D	1
		2M	3M	3	3M	0	3M	0
		1D	1M	2	1M	0	1D	-2
		2S	3D	2	3M	2	3M	0
		2M	4S	5	5D	2	5S	1
		EntryD	3S	10	3S	0	3M	1
		2S	3M	4	3M	0	4D	1
		1S	2M	4	3D	1	3D	0
		2M	3S	2	3M	1	4D	1
		2S	3S	3	3D	-1	3S	1
		EntryD	3M	11	4D	1	4D	0
		2S	3M	4	3S	-1	3M	1
		2S	3S	3	3S	0	3M	1
		3S	4M	4	5D	1	5M	2
		2S	3S	3	3M	1	4D	1
		3S	4D	2	4D	0	4S	1
		2M	3S	2	3D	-1	3S	1
		1D	2D	3	2S	1	2S	0
		2M	4S	5	3M	-2	4D	1
		EntryD	2S	7	2S	0	2M	1
		2S	3M	4	3M	0	4D	1
		3S	3M	1	3S	-1	4D	2
		2D	3M	5	3M	0	4D	1
		EntryD	2S	7	2S	0	3D	2
		1S	3M	7	3M	0	3M	0
		2M	3M	3	3M	0	4D	1
		EntryS	2S	6	2M	1	2S	-1
		3D	4M	5	5S	2	5M	1
		2M	3M	3	3S	-1	4D	2
		2M	4D	4	4D	0	4S	1
		2D	3S	4	3S	0	3M	1
		3D	4S	4	5D	2	5M	2
		2D	3S	4	3S	0	3M	1
		2M	3D	1	3M	2	3S	-1
		2M	3S	2	3S	0	3S	0

		1S	3D	5	3S	1	3D	-1
		2S	3S	3	3M	1	3M	0
		2M	3S	2	3S	0	3S	0
		1M	3D	4	2M	-1	2S	-1
		2S	3M	4	3M	0	3M	0
		2M	3S	2	3S	0	3M	1
		1S	3D	5	3D	0	3D	0
		2S	3D	2	3S	1	4D	2
		2M	3M	3	3S	-1	3M	1
		2M	4D	4	3S	-2	3M	1
		2S	4D	5	3S	-2	3S	0
		1D	2D	3	2D	0	2M	2
		2M	3S	2	3M	1	4S	2
		1D	2S	4	2M	1	3D	1
		2S	3S	3	3M	1	3M	0
		2S	3S	3	3S	0	3M	1
		3S	3M	1	4S	2	5D	2
		3S	4D	2	4M	2	5S	2
		2S	2D	-1	2M	2	2S	-1
		3S	4M	4	5S	2	6D	2
		EntryD	2M	8	2M	0	3D	1
		2M	4D	5	3M	-1	4S	2
		2D	3D	3	3M	2	3M	0
		2S	3S	3	3M	1	4D	1
		2M	4S	5	4D	-1	4S	1
		2S	3M	4	3M	0	3M	0
		2M	4D	4	4M	2	4M	0
		1M	3S	5	3D	-1	3D	0
		2D	3S	4	3D	-1	3D	0
		1S	2D	2	2S	1	2M	1
		3S	3M	1	4D	1	4D	0
		3D	4S	4	5D	2	5D	0
		2D	3M	5	3M	0	3M	0
		2S	3M	4	4D	1	4S	1
		1M	3S	5	3S	0	3M	1
		3D	4D	3	4D	0	4S	1
		2M	3S	2	3M	1	4D	1

3S	3S	0	3S	0	3S	0
2S	3D	2	3D	0	3S	1
2D	3S	4	4D	0	4S	1
2M	4M	6	5D	1	5M	2
4D	4S	1	4M	1	4M	0
2D	3S	4	3S	0	3M	1
3M	4M	3	5D	1	5S	1
2M	3S	2	4D	0	3M	-1
2M	4S	5	4D	-1	4S	1
2S	3M	4	3S	-1	3M	1
1S	2S	3	2M	1	3D	1
2D	2M	1	2M	0	3D	1
3S	3M	1	3M	0	4D	1
4D	5D	3	5S	1	5M	1
2S	4S	6	4M	1	5S	2
3S	3S	0	3S	0	3M	1
EntryD	3S	10	4D	0	4D	0
1S	3S	6	3S	0	4D	2
2D	3S	4	3M	1	4D	1
3M	4M	3	4M	0	4S	-1
2M	4S	5	4S	0	4S	0
3S	4D	2	4D	0	4D	0
1S	2D	2	2D	0	2M	2
2M	3S	2	3S	0	3M	1
3S	3M	1	3M	0	4D	1
2S	3M	4	3S	-1	3S	0
1S	3D	5	3S	1	4D	2
3S	4S	3	3M	-2	4D	1
2S	3M	4	3M	0	3M	0

Appendix 13 - Questionnaire results

<u>Question key</u>

	Interest in maths	(Perceived) Efficiency in maths	Motivation in maths	Taking pleasure in maths	Attributing maths success or failure to chance
1. Mathematics is useful and necessary in all areas of life	Y				
2. Mathematics is difficult, boring and not needed in the real world	Y				
3. The only maths that interests me is what will be in a test or exam, because it is the most important and what I have to know	Y				
4. If I know how to solve a problem the teacher showed us in class, I will be able to solve other problems of the same type		Y			
5. The skills I use in class to solve maths problems have nothing to do with the skills I use to solve problems in everyday life	Y				
6. I look for different ways and methods to solve a maths problem			Y		
7. I learn a lot by inventing new maths problems			Y		
8. I will do better in maths if the teacher likes me					Y
9. When I spend more time studying maths I get better at solving problems		Y			
10. I have confidence in myself when faced with math problems		Y			
11. I consider myself very capable and skilled in mathematics					Y
12. I am calm and relaxed when I solve math problems			Y		
13. When I solve a maths problem successfully it is more down to luck than my own skill					Y
14. Maths is only for intelligent people					Y
15. People who are good at maths do not have to spend time thinking about how to solve a problem					Y
16. Maths classes go on for a long time, I'm not comfortable and I feel like running away	Y				
17. I enjoy the days that we do not have maths classes because they do not interest me				Y	

18. When faced with a complicated problem, I easily give up			Y		
19. When I am faced with a problem I am very curious to know the solution				Y	
20. I get anxious and I feel scared when the teacher asks me to solve a problem in front of the class				Y	
21. When I get stuck when trying to solve a problem I start to feel insecure, desperate and nervous				Y	
22. If I can not find the solution to a problem, I get the feeling that I have failed and that I have wasted my time		Y			
23. It gives me great satisfaction to successfully solve a mathematical problem				Y	
24. When my attempts to solve a problem fail, I try again			Y		
25. I believe I can solve even difficult maths problems if I really try		Y			

Year 8 pre-intervention questionnaire results

	Interest in maths						(Perceived) Efficiency in maths						Motivation in maths						Attributing maths success or failure to chance						Taking pleasure in maths					
	Q1	Q2	Q3	Q5	Q16	Total	Q4	Q9	Q10	Q22	Q25	Total	Q6	Q7	Q12	Q18	Q24	Total	Q8	Q11	Q13	Q14	Q15	Total	Q17	Q19	Q20	Q21	Q23	Total

Year 8 post-intervention questionnaire results

Interest in maths

	Q1	Q2	Q3	Q5	Q16	Tota
SUM	46	46	35	43	45	
ARITHMETIC MEAN	3.83	3.83	2.92	3.58	3.75	
MODE	4	4	2	4	5	
MIN	3	2	2	2	1	
LQ	3.75	4	2	2.75	2.75	
MEDIAN	4	4	4	4	4	
UQ	5	5	5	4	5	
IQR	0.25	0	2	1.25	2.25	
RANGE	2	3	3	3	4	

(Perceived) Efficiency in maths

	Q4	Q9	Q10	Q22	Q25	Tota
SUM	54	52	49	46	54	
ARITHMETIC MEAN	4.50	4.33	4.08	3.83	4.50	
MODE	5	4	4	4	5	
MIN	3	4	3	2	4	
LQ	4	4	3.75	3.75	4	
MEDIAN	5	4	5	4	4.5	
UQ	5	5	5	4.25	5	
IQR	1	1	1.25	0.5	0.5	
RANGE	2	1	2	3	1	

Motivation in maths

	Q6	Q7	Q12	Q18	Q24	Tota
SUM	48	47	45	49	53	
ARITHMETIC MEAN	4.00	3.92	3.75	4.08	4.42	
MODE	4	4	4	4	5	
MIN	2	2	2	3	2	
LQ	4	3.75	3	4	4	
MEDIAN	5	4	4	4	5	
UQ	5	4.25	4	4	5	
IQR	1	0.5	1	0	1	
RANGE	3	3	3	2	3	

Attributing maths success or failure to chance

	Q8	Q11	Q13	Q14	Q15	Tota
SUM	53	41	42	51	47	
ARITHMETIC MEAN	4.42	3.42	3.50	4.25	3.92	
MODE	4	4	4	5	4	
MIN	3	2	2	4	2	
LQ	4	2.75	3	4	3.75	
MEDIAN	5	4	3.5	4.5	4	
UQ	5	4	4	5	4.25	
IQR	1	1.25	1	1	0.5	
RANGE	2	3	3	3	3	

Taking pleasure in maths

	Q17	Q19	Q20	Q21	Q23	Tota
SUM	47	44	38	41	51	
ARITHMETIC MEAN	3.92	3.67	3.17	3.42	4.25	
MODE	4	4	2	4	4	
MIN	2	1	1	1	3	
LQ	3.75	3	2	2.75	4	
MEDIAN	5	4	3	4	4	
UQ	5	4.25	4.25	4	5	
IQR	1.25	1.25	2.25	1.25	1	
RANGE	3	4	4	4	2	

Section totals

	Interest	Efficiency	Motivation	Attributing	Pleasure
SUM	215	255	242	234	221
ARITHMETIC MEAN	3.58	4.25	4.03	3.90	3.68
MEDIAN	4	4	4	4	4
MODE	4	4	4	4	4
RANGE	4	3	3	3	4
MIN	1	2	2	2	1
LQ	3	4	4	3	3
UQ	4	4	4	5	5
MAX	5	5	5	5	5
IQR	1	1	1	2	2

Year 8 pre and post intervention summary

Interest in maths			(Perceived) Efficiency in maths			Motivation in maths			Attributing maths success or failure to chance			Taking pleasure in maths			
Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	Overall change
19	20	1	18	20	2	18	18	0	20	21	1	19	21	2	6
17	20	3	18	23	5	18	20	2	23	23	0	22	22	0	10
18	18	0	20	21	1	20	20	0	18	18	0	16	16	0	1
16	20	4	20	23	3	22	22	0	20	20	0	22	22	0	7
19	19	0	19	19	0	17	17	0	20	20	0	16	16	0	0
14	14	0	18	18	0	12	14	2	14	14	0	10	10	0	2
13	13	0	21	21	0	22	22	0	19	20	1	19	19	0	1
11	11	0	20	24	4	20	20	0	15	15	0	14	15	1	5
19	22	3	20	23	3	20	22	2	22	22	0	19	19	0	8
15	23	8	19	24	5	25	25	0	20	22	2	25	25	0	15
16	17	1	21	21	0	20	22	2	20	20	0	18	18	0	3
18	18	0	18	18	0	20	20	0	19	19	0	18	18	0	0

Year 10 pre-intervention questionnaire results

Interest in maths

Student identifier number	Q1	Q2	Q3	Q5	Q16
3	A 4	D 4	A 2	D 4	D 4
4	SA 5	SD 5	A 2	D 4	SD 5
5	A 4	D 4	D 2	D 4	SD 5
6	A 4	D 4	N 4	A 2	SD 5
7	A 4	N 3	A 3	SD 5	SD 5
8	A 4	D 4	A 2	D 4	SD 5
9	A 4	D 4	D 4	D 4	SD 5
10	A 4	SD 5	A 4	SD 5	SD 5
11	SA 5	SD 5	A 2	SD 5	SD 5
12	SA 5	SD 5	A 2	D 2	D 4
SUM	53	51	34	51	57
ARITHMETIC MEAN	4.42	4.25	2.83	4.25	4.75
MODE	4	4	2	4	5
MIN	4	3	2	2	4
LQ	4	4	2	4	4.75
MEDIAN	4	4	2.5	4	5
UQ	5	5	4	5	5
MAX	5	5	4	5	5
IQR	1	1	2	1	0.25
RANGE	1	2	2	3	1

Category summary (Interest in maths): SUM 246, ARITHMETIC MEAN 4.10, MEDIAN 4, MODE 4, RANGE 3, MIN 2, LQ 4, UQ 5, MAX 5, IQR 1

(Perceived) Efficiency in maths

Student identifier number	Q4	Q9	Q10	Q22	Q25
3	SA 5	A 4	A 4	D 4	A 4
4	SA 5	SA 5	A 4	SD 5	A 4
5	A 4	A 4	A 4	N 3	A 4
6	SA 5	A 4	SA 5	SD 5	A 4
7	SA 5	A 4	A 4	D 4	SA 5
8	SA 5	SA 5	SA 5	D 4	SA 5
9	A 4	A 4	A 4	D 4	A 4
10	A 4	SA 5	SA 5	SD 5	SA 5
11	SA 5	SA 5	SA 5	SD 5	SA 5
12	SA 5	SA 5	A 4	D 4	A 4
SUM	56	55	53	52	54
ARITHMETIC MEAN	4.67	4.58	4.42	4.33	4.50
MODE	5	5	4	4	4
MIN	4	4	4	3	4
LQ	4	4	4	4	4
MEDIAN	5	5	4	4	4.5
UQ	5	5	5	5	5
MAX	5	5	5	5	5
IQR	1	1	1	1	1
RANGE	1	1	1	2	1

Category summary ((Perceived) Efficiency in maths): SUM 270, ARITHMETIC MEAN 4.50, MEDIAN 5, MODE 5, RANGE 2, MIN 3, LQ 4, UQ 5, MAX 5, IQR 1

Motivation in maths

Student identifier number	Q6	Q7	Q12	Q18	Q24
3	A 4	A 4	A 4	A 4	A 4
4	A 4	A 4	A 4	SD 5	SA 5
5	A 4	A 4	A 4	D 4	A 4
6	SA 5	SA 5	SA 5	SD 5	D 2
7	A 4	A 4	A 4	A 4	A 4
8	SA 5	SA 5	SA 5	A 4	SA 5
9	A 4	SA 5	A 4	A 4	SA 5
10	SA 5	SA 5	SA 5	A 4	SA 5
11	SA 5	A 4	A 4	A 4	SA 5
12	A 4	A 4	A 4	A 4	SA 5
SUM	52	54	53	51	53
ARITHMETIC MEAN	4.33	4.50	4.42	4.25	4.42
MODE	4	5	4	4	5
MIN	4	4	4	4	2
LQ	4	4	4	4	4
MEDIAN	4	4.5	4	4	5
UQ	5	5	5	4.25	5
MAX	5	5	5	5	5
IQR	1	1	1	0.25	1
RANGE	1	1	1	1	3

Category summary (Motivation in maths): SUM 263, ARITHMETIC MEAN 4.38, MEDIAN 4, MODE 4, RANGE 3, MIN 2, LQ 4, UQ 5, MAX 5, IQR 1

Attributing maths success or failure to chance

Student identifier number	Q8	Q11	Q13	Q14	Q15	Q17
3	D 4	A 4	SD 5	D 4	D 4	D 4
4	D 4	A 4	N 3	SD 5	D 4	SD 5
5	D 4	A 4	D 4	D 4	D 4	D 4
6	SD 5	SA 5	SD 5	A 2	SD 5	A 2
7	SD 5	A 4	SD 5	SD 5	N 3	N 3
8	SD 5	SA 5	SD 5	SD 5	SD 5	SD 5
9	D 4	A 4	D 4	SD 5	SD 5	SD 5
10	SD 5	SA 5	SD 5	SD 5	SD 5	D 4
11	D 4	SA 5	SD 5	SD 5	SD 5	D 4
12	D 4	SA 5	D 4	D 4	D 4	D 4
SUM	53	54	52	51	50	50
ARITHMETIC MEAN	4.42	4.50	4.33	4.25	4.17	4.17
MODE	4	4	5	5	4	4
MIN	4	4	3	2	3	2
LQ	4	4	4	4	4	4
MEDIAN	4	4.5	4.5	4.5	4	4
UQ	5	5	5	5	5	5
MAX	5	5	5	5	5	5
IQR	1	1	1	1	1	1
RANGE	1	1	2	3	2	3

Category summary (under Q8): SUM 260, ARITHMETIC MEAN 4.33, MEDIAN 4, MODE 5, RANGE 3, MIN 2, LQ 4, UQ 5, MAX 5, IQR 1

Category summary (under Q17): SUM 236, ARITHMETIC MEAN 3.93, MEDIAN 4, MODE 4, RANGE 4, MIN 1, LQ 4, UQ 5, MAX 5, IQR 1

Taking pleasure in maths

Student identifier number	Q19	Q20	Q21	Q23
3	A 4	A 2	SD 5	A 4
4	SA 5	D 4	SD 5	N 3
5	SA 5	A 2	D 4	A 4
6	SD 1	A 2	SD 5	A 4
7	A 4	A 4	N 3	SA 5
8	SA 5	D 2	D 4	SA 5
9	A 4	A 2	D 4	A 4
10	SA 5	D 4	SD 5	SA 5
11	A 4	A 2	D 4	A 4
12	N 3	D 4	N 3	A 4
SUM	49	36	50	51
ARITHMETIC MEAN	4.08	3.00	4.17	4.25
MODE	5	4	4	4
MIN	1	2	3	3
LQ	4	2	4	4
MEDIAN	4	3	4	4
UQ	5	4	5	5
MAX	5	4	5	5
IQR	1	2	1	1
RANGE	4	2	2	2

This page contains a large rotated spreadsheet of Year 10 post-intervention questionnaire results. Each question column records a numeric rating (1–5) and a Likert code (SA, A, N, D, SD) for each of 12 students, followed by summary statistics.

Question groupings:

Category	Questions
Interest in maths	Q1, Q2, Q3, Q5, Q16
(Perceived) Efficiency in maths	Q4, Q9, Q22, Q25
Motivation in maths	Q6, Q7, Q12, Q18, Q24
Attributing maths success or failure to chance	Q8, Q11, Q13, Q14, Q15
Taking pleasure in maths	Q17, Q19, Q20, Q21, Q23

Per-question summary statistics (first block):

Stat	Q1	Q2	Q3	Q5	Q16	Q4	Q9	Q22	Q25	Q6	Q7	Q12	Q18	Q24	Q8	Q11	Q13	Q14	Q15	Q17	Q19	Q20	Q21	Q23
SUM	54	48	32	53	56	56	55	52	55	54	53	54	53	52	54	56	53	46	50	53	50	35	48	52
ARITHMETIC MEAN	4.50	4.00	2.67	4.42	4.67	4.67	4.58	4.33	4.58	4.50	4.42	4.50	4.42	4.33	4.50	4.67	4.42	3.83	4.17	4.42	4.17	2.92	4.00	4.33
MODE	5	4	2	5	5	5	5	4	5	4	4	5	4	5	5	5	5	5	4	4	5	2	4	5
MIN	4	3	2	2	4	4	4	3	4	4	4	4	4	2	4	4	3	1	3	4	1	1	2	3
LQ	4	4	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3.5	4	4	4	2	4	4
MEDIAN	4.5	4	2	5	5	5	5	4	5	4.5	4	4.5	4	4.5	4.5	5	4.5	4	4	4	4.5	2.5	4	4.5
UQ	5	5	3.25	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4.25	5
MAX	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
IQR	1	1	1.25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1	1	1	2	0.25	1
RANGE	1	2	2	3	1	1	1	2	1	1	1	1	1	3	1	1	2	4	2	1	4	4	3	2

Per-category summary statistics (second block, shown under the first column of each group):

Stat	Interest (Q1)	Efficiency (Q4)	Motivation (Q6)	Attributing (Q8)	Pleasure (Q17)
SUM	243	272	266	259	238
ARITHMETIC MEAN	4.05	4.53	4.43	4.32	3.97
MEDIAN	4	5	4	4	4
MODE	4	5	4	5	4
RANGE	3	2	3	4	4
MIN	2	3	2	1	1
LQ	4	4	4	4	4
UQ	5	5	5	5	5
MAX	5	5	5	5	5
IQR	1	1	1	1	1

112

Year 10 pre and post intervention summary

Interest in maths			(Perceived) Efficiency in maths			Motivation in maths			Attributing maths success or failure to chance			Taking pleasure in maths			Overall change
Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	
20	19	-1	23	24	1	22	21	-1	21	21	0	22	22	0	-1
21	21	0	24	23	-1	23	23	0	23	23	0	21	21	0	-1
18	19	1	21	21	0	20	22	2	21	24	3	19	17	-2	4
21	20	-1	23	23	0	22	24	2	20	23	3	22	20	-2	2
21	21	0	19	21	2	20	21	1	20	20	0	19	19	0	3
19	18	-1	23	23	0	21	22	1	22	20	-2	14	18	4	2
20	20	0	22	23	1	22	21	-1	20	19	-1	19	21	2	1
20	20	0	24	22	-2	23	22	-1	21	20	-1	21	21	0	-4
21	21	0	23	21	-2	22	22	0	22	22	0	19	18	-1	-3
23	21	-2	24	25	1	25	24	-1	25	24	-1	24	23	-1	-4
22	21	-1	22	23	1	22	22	0	24	24	0	18	19	1	1
20	22	2	22	23	1	21	22	1	21	19	-2	18	19	1	3

Summary of results

Interest in maths						
	Tutees before	Tutees after	Tutees change	Tutors before	Tutors after	Tutors change
Mean	3.25	3.58	0.33	4.10	4.05	-0.05
Median	3.5	4	0.5	4	4	0
Mode	4	4	0	4	4	0
Range	4	4	0	3	3	0
Interest in maths						
	Tutees before	Tutees after	Tutors before	Tutors after		
Min	1	1	2	2		
LQ	2	3	4	4		
UQ	4	4	5	5		

113

Max	5	5	5	5		

(Perceived) Efficiency in maths						
	Tutees before	Tutees after	Tutees change	Tutors before	Tutors after	Tutors change
Mean	3.87	4.25	0.38	4.50	4.53	0.03
Median	4	4	0	5	5	0
Mode	4	4	0	5	5	0
Range	3	3	0	2	2	0

(Perceived) Efficiency in maths					
	Tutees before	Tutees after	Tutors before	Tutors after	
Min	2	2	3	3	
LQ	3.75	4	4	4	
UQ	4	5	5	5	
Max	5	5	5	5	

Motivation in maths						
	Tutees before	Tutees after	Tutees change	Tutors before	Tutors after	Tutors change
Mean	3.90	4.03	0.13	4.38	4.43	0.05
Median	4	4	0	4	4	0
Mode	4	4	0	4	4	0
Range	3	3	0	3	3	0

Motivation in maths					
	Tutees before	Tutees after	Tutors before	Tutors after	
Min	2	2	2	2	
LQ	3.75	4	4	4	
UQ	4	5	5	5	
Max	5	5	5	5	

Attributing maths success or failure to chance

	Tutees before	Tutees after	Tutees change	Tutors before	Tutors after	Tutors change
Mean	3.83	3.90	0.07	4.33	4.32	-0.02
Median	4	4	0	4	4	0
Mode	4	4	0	5	5	0
Range	3	3	0	3	4	1
Attributing maths success or failure to chance						
	Tutees before	Tutees after	Tutors before	Tutors after		
Min	2	2	2	1		
LQ	3	3	4	4		
UQ	4	5	5	5		
Max	5	5	5	5		
Taking pleasure in maths						
	Tutees before	Tutees after	Tutees change	Tutors before	Tutors after	Tutors change
Mean	3.63	3.68	0.05	3.93	3.97	0.03
Median	4	4	0	4	4	0
Mode	4	4	0	4	4	0
Range	4	4	0	4	4	0
Taking pleasure in maths						
	Tutees before	Tutees after	Tutors before	Tutors after		
Min	1	1	1	1		
LQ	3	3	4	4		
UQ	4	5	5	5		
Max	5	5	5	5		

Appendix 14 - Correlation between academic test data and questionnaire results for Year 8 students

Participant number	Progress between the start and end of the intervention	Interest in maths			(Perceived) Efficiency in maths			Motivation in maths			Attributing maths success or failure to chance			Taking pleasure in maths			Overall change
		Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	
1	0	19	20	1	18	20	2	18	18	0	20	21	1	19	21	2	6
2	1	17	20	3	18	23	5	18	20	2	23	23	0	22	22	0	10
3	1	18	18	0	20	21	1	20	20	0	18	18	0	16	16	0	1
4	0	16	20	4	20	23	3	22	22	0	20	20	0	22	22	0	7
5	1	19	19	0	19	19	0	17	17	0	20	20	0	16	16	0	0
6	1	14	14	0	18	18	0	12	14	2	14	14	0	10	10	0	2
7	0	13	13	0	21	21	0	22	22	0	19	20	1	19	19	0	1
8	1	11	11	0	20	24	4	20	20	0	15	15	0	14	15	1	5
9	0	19	22	3	20	23	3	20	22	2	22	22	0	19	19	0	8
10	1	15	23	8	19	24	5	25	25	0	20	22	2	25	25	0	15
11	1	16	17	1	21	21	0	20	22	2	20	20	0	18	18	0	3
12	2	18	18	0	18	18	0	20	20	0	19	19	0	18	18	0	0